

T. N. Brown

DESCRIPTIVE CATALOGUE  
OF THE  
SPECIMENS ILLUSTRATING  
SURGICAL PATHOLOGY  
IN THE  
MUSEUM OF UNIVERSITY COLLEGE, LONDON.

NEW EDITION.

BY

RAYMOND JOHNSON, B.S., F.R.C.S.,

ASSISTANT-SURGEON TO UNIVERSITY COLLEGE HOSPITAL,

AND

T. W. P. LAWRENCE, M.B., F.R.C.S.,

CURATOR OF THE MUSEUM.

---

PART I.

INJURIES AND DISEASES OF BONES AND JOINTS.

---

COPIES MAY BE OBTAINED AT THE OFFICE OF THE COLLEGE.

1899.

M19445



22501625024

**Wellcome Library  
for the History  
and Understanding  
of Medicine**





# DESCRIPTIVE CATALOGUE

OF THE

SPECIMENS ILLUSTRATING

# SURGICAL PATHOLOGY

IN THE

MUSEUM OF UNIVERSITY COLLEGE, LONDON.

NEW EDITION.

BY

RAYMOND JOHNSON, B.S., F.R.C.S.,

ASSISTANT-SURGEON TO UNIVERSITY COLLEGE HOSPITAL,

AND

T. W. P. LAWRENCE, M.B., F.R.C.S.,

CURATOR OF THE MUSEUM.

---

## PART I.

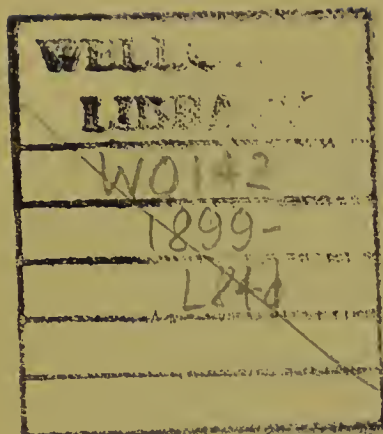
INJURIES AND DISEASES OF BONES AND JOINTS.

---

COPIES MAY BE OBTAINED AT THE OFFICE OF THE COLLEGE.

1899.

M19445



PRINTED BY TAYLOR AND FRANCIS,  
RED LION COURT, FLEET STREET.

## PREFACE.

---

SINCE the First Edition of this Catalogue was prepared by the late Mr. Marcus Beck, Mr. S. G. Shattock, and Mr. C. Stonham, so large a number of new specimens have been added to the series illustrating Surgical Pathology that the preparation of a new edition has become necessary.

For purposes of convenience the present Edition will appear in three parts. Part I. includes a description of the specimens illustrating Injuries and Diseases of the Bones and Joints; Part II. will deal with Injuries and Diseases of the Muscles and Bursæ, Circulatory and Lymphatic Systems, the Nerves, the Alimentary Canal, the Air-passages and the Thyroid Gland; Part III. will include Injuries and Diseases of the Urinary Organs, the Male Generative Organs and the Mammary Gland, together with Malformations, and Diseases of the Skin, Ear, Nose and Eye.

In dealing with the specimens illustrating the Morbid Anatomy of the Bones and Joints considerable re-arrangement has been found necessary, chiefly on account of the fact that since the publication of the First Edition, the Tuberculous nature of many of the chronic inflammatory affections of the Bones and Joints has been fully recognised.

The general plan adopted in the First Edition has been preserved. Each section is preceded by a short description of the pathological conditions illustrated by the specimens, with a reference, by numbers in brackets, to those specimens in which each condition is best displayed.

We take this opportunity of acknowledging our indebtedness to Professor Thane for many helpful suggestions.

University College,  
October, 1899.

RAYMOND JOHNSON.  
T. W. P. LAWRENCE.

*Note.*—The numbers following the descriptions of the specimens are those in the MS. Catalogue.



# TABLE OF CONTENTS.

## PART I.

INJURIES AND DISEASES OF BONE.	Numbers	Page
SERIES I. FRACTURES .....	1 to 327	1
Union of Fractures .....	11 to 24	4
Deviations from Normal Repair .....	25 to 49	7
Spontaneous Fractures .....	50 to 56	13
Gunshot Fractures .....	57 to 86	15
Injuries of the Bones of the Skull .....	88 to 148	20
Cephalhæmatoma .....	88	20
Contusions of the Vault .....	89 to 92	20
Fissured Fractures of the Vault.....	93 to 101	23
Fractures with Depression .....	102 to 122	24
Incised and Punctured Fractures .....	123 to 128	29
Fractures of the Base .....	129 to 138	30
Fractures of the Bones of the Face .....	139 to 148	33
Fractures and Fracture-Dislocations of the Spine ..	149 to 160	34
Fractures of the Sternum and Ribs .....	161 to 171	37
" " Clavicle .....	172 to 180	39
" " Scapula .....	181 to 187	40
" " Humerus .....	188 to 200	41
" " Ulna .....	201 to 207	43
" " Radius .....	208 to 217	44
" " Radius and Ulna .....	218 to 221	46
" " Bones of the Hand .....	222	46
" " Pelvis .....	223 to 229	47
" " Femur .....	230 to 284	48
" " Patella .....	285 to 299	57
" " Bones of the Leg .....	300 to 324	59
" " Bones of the Foot .....	325 to 327	62
SERIES II. DISEASES OF BONE .....	328 to 774	63
Hypertrophy of Bone .....	328 to 331	63
Atrophy of Bone .....	332 to 345	64
Inflammation of Bone .....	346 to 445	66
Inflammation of the Periosteum .....	346 to 353	66
" " Compact Bone .....	354 to 363	68
" " Cancellous Bone .....	364 to 370	70
" " Medulla .....	371 to 374	72
Osteoplastic Inflammation .....	375 to 387	74
Rarefactive Inflammation .....	388 to 396	76
Necrosis of Bone .....	397 to 445	78

DISEASES OF BONE (*continued*).

	Numbers	Page
Acute Infective Suppuration of Bone .....	446 to 469	89
Tuberculous Disease of Bone .....	470 to 537	98
Tuberculous Disease of the Skull .....	470 to 472	99
"        "        "    Vertebræ .....	473 to 509	101
"        "        "    Sternum and Ribs ..	510 to 513	110
"        "        "    Bones of the Upper		
Limb .....	514 to 522	111
"        "        "    Bones of the Lower		
Limb .....	523 to 537	113
Syphilitic Disease of Bone .....	538 to 603	116
Syphilitic Disease of the Skull .....	574 to 603	122
Rickets .....	604 to 632	127
Achondroplasia .....	633 to 641	133
Mollities Ossium. Osteomalacia .....	642 to 645	136
Osteitis Deformans .....	646 to 654	137
Acromegaly .....		140
Leontiasis Ossea .....		140
Tumours of Bone .....	655 to 774	141
Cartilaginous Tumours .....	655 to 661	141
Osseous Tumours .....	662 to 686	143
Fibrous Tumours .....		147
Fibro-sarcomata .....	687 to 689	147
Spindle-cell Sarcomata .....	690 to 698	148
Round-cell Sarcomata .....	699 to 711	152
Ossifying and Chondrifying Sarcomata .....	712 to 729	156
Myeloid Sarcomata .....	730 to 737	163
Secondary Malignant Tumours .....	738 to 753	166
Wax Models of Tumours of Bone .....	754 to 761	171
Bones altered by the Growth of Tumours ....	762 to 774	172

## INJURIES AND DISEASES OF JOINTS.

SERIES I. DISLOCATIONS .....	775 to 815	176
Dislocations of the Spinal Column .....	778 to 780	177
"        "    Joints of the Upper Limb .....	781 to 799	179
"        "    Sterno-clavicular and Acromio-		
clavicular Articulations....	781	179
"        "    Shoulder-joint .....	782 to 788	179
"        "    Elbow-joint .....	789 to 794	180
"        "    Wrist-joint and Carpus .....	795 to 797	181
"        "    Phalanges .....	798,	182
"        "    Joints of the Lower Limb ....	800 to 815	182
"        "    Hip-joint .....	800 to 802	182
"        "    Patella .....	803 to 807	184
"        "    Knee-joint .....	808	184
"        "    Ankle-joint and Tarsus .....	809 to 815	185
SERIES II. DISEASES OF JOINTS .....	816 to 1064	187
Acute Inflammation with Suppuration .....	816 to 829	187
Tuberculous Disease of Joints .....	830 to 842	190
"        "    Special Joints .....	843 to 914	195
"        "    Vertebræ .....	843,	195
"        "    Shoulder-joint .....	845 to 850	196
"        "    Elbow-joint .....	851 to 865	197
"        "    Wrist-joint and Articulations		
of Hand .....	866 to 869	200
"        "    Sacro-iliac Articulation ....	870 to 873	202
"        "    Hip-joint .....	874 to 892	203
"        "    Knee-joint .....	893 to 906	209
"        "    Ankle-joint and Articulations		
of Foot .....	907 to 914	213



DISEASES OF JOINTS ( <i>continued</i> ).	Numbers	Page
Syphilitic Disease of Joints .....		215
Rheumatoid Arthritis .....	915 to 980	215
Gout .....	981 to 993	229
Neuropathic Affections of Joints .....	994 to 998	231
Loose Bodies in Joints .....	999 to 1010	234
Ankylosis .....	1011 to 1064	237
<i>a.</i> Simple Adhesions .....	1011	237
<i>b.</i> Fibrous Ankylosis .....	1012 to 1021	237
<i>c.</i> Osseous Ankylosis .....	1022 to 1064	239

END OF PART I.





# INJURIES AND DISEASES

OF

## BONE.

---

### SERIES I.—FRACTURES.

A bone may be bruised or broken.

A *contusion* of bone frequently results in an extravasation of blood beneath the periosteum (88), but if unaccompanied by an open wound the injury is unlikely to destroy the vitality of the bone. Should, however, the bruised bone be exposed in a septic wound, especially if the periosteum has been stripped from it by the injury, necrosis is very likely to ensue (89), and various complications may arise from the extension of suppuration into the interior of the bone.

*Fractures* are divided primarily into simple or closed, and compound or open. In dried preparations compound fractures are not distinguishable from simple ones except in the case of those in which necrosis of the fragments has occurred (41), or in which evidence is present that the injury was caused by gunshot. A fracture, whether simple or compound, is said to be complicated when, in addition to the lesion of the bone, there exists some more or less important injury to the neighbouring structures. Amongst the most important complications of fractures of the limb-bones are :—

- Extensive laceration of the soft parts.
- Implication of a neighbouring joint (275).
- Dislocation.
- Wounds of large vessels.
- Injury to nerve-trunks.

In many fractures of the skull, spine, ribs, and pelvis, the fracture itself is of small importance compared with the injury to important organs with which it is often associated.

Fractures are also divided into :—

- Single, in which one bone is broken in one place only (1).
- Multiple, in which one bone is broken in more than one situation (2), or in which fracture occurs in more bones than one.
- Comminuted, in which a variable number of smaller pieces of bone are separated from one or both of the main fragments (3), or in which one of the latter is separated into several parts.
- Impacted, when the end of one fragment, usually the smaller and more compact, is driven into the substance of the other (4).

According to their direction, fractures, especially of the long bones, are divided into :—

Transverse, more commonly met with near the articular end of a bone than in the shaft (5). In children such a fracture may occur through the epiphysial line.

Oblique, the commonest variety of fracture in the shafts of the long bones (6). An oblique fracture continued around the long axis of a long bone becomes spiral (7).

Longitudinal, in which a split or fissure passes in the direction of the long axis of the bone (8).

Fractures are also classified, according to the nature of the injury to the bone, into :—

Fissured, in which a split or crack extends through the whole or a part of the thickness of the bone, as in the flat bones (9). In a stellate fracture several fissures radiate from the same point.

Depressed, in which, most commonly in one of the flat bones of the skull, a portion of bone is driven below its proper level (10).

Incised and punctured fractures, which are also most frequent in the bones of the roof of the skull, are caused by cuts or punctures of the overlying soft parts extending into the bone, and involving a part or the whole of its thickness (128). The chief danger of such fractures is the contamination of the bone with septic matter.

Incomplete or "Greenstick" fractures, which are met with almost exclusively in young subjects, are characterized by a bending of the bone without its separation into two fragments.

Fractures may be produced by :—

Direct violence (184).

Indirect violence (40).

Muscular action (285).

Spontaneous fractures and gunshot fractures are arranged in separate series.

1. A left tibia which has been fractured through the junction of its middle and lower thirds. Firm union has occurred after slight displacement of the lower fragment outwards; the lower fragment has also been bent backwards by the muscles of the calf so as to give to the whole bone a long forward curvature.

215

2. A left tibia fractured in its upper and lower thirds. The upper fracture, which is comminuted, extends obliquely downwards and inwards from a point 12 mm. below the articular surface for the fibula, and union has occurred after slight displacement of the lower fragment upwards and outwards and angular deformity backwards. A large fragment separated from the posterior aspect of the bone is firmly united by its extremities to the main fragments.

The lower fracture has an oblique direction downwards and forwards, and is firmly united after slight displacement of the lower fragment upwards and backwards. On the outer aspect of the lower fragment is a regularly oval cup-shaped depression which evidently articulated with a long projection from the fibula.

7067

Excavated from a supposed plague-pit in Whitechapel.

3. The upper part of a right femur which has been sawn through longitudinally. The part of the bone which includes the trochanters is entirely separated from the shaft below and the neck above, and is itself broken up into several frag-

ments, some of the smaller of which are missing. The three chief fragments include the small trochanter and the posterior and anterior parts of the great trochanter. 4259

4. The upper part of a right femur, the head and neck of which have been separated by a fracture passing round the base of the latter. The neck has been driven deeply into the cancellous tissue of the great trochanter, and has caused a fracture passing downwards from the upper border of the trochanter in a direction parallel to the posterior intertrochanteric line, and reaching as low as the small trochanter. 1232

5. A vertical section of a left humerus, from a young subject, showing a transverse fracture through the middle of the shaft. 2635

The other half of the specimen is fully described in No. 13.

6. The leg-bones of the right side, showing an oblique fracture at the junction of the lower and middle thirds of the shaft of the tibia. The line of the fracture passes from above downwards and forwards, and repair has occurred after displacement of the lower fragment upwards behind the upper, the wedge-like end of which stands out prominently upon the front of the bone. The fibula has been fractured at a somewhat higher level than the tibia and union has occurred, the upper end of the lower fragment overlapping the upper fragment on its inner surface. 3123

7. The upper half of a right femur in which a comminuted fracture involves the trochanters. From the upper border of the great trochanter a fracture passes vertically along its outer surface, and is continued downwards in a spiral direction across the anterior and inner aspects of the shaft, reaching the linea aspera 12 cm. below the small trochanter. At this point the fracture is joined by another, which passes longitudinally downwards from the small trochanter. 6747

8. The lower three-fourths of a right tibia of which the shaft has been recently fractured in an oblique direction from without inwards and downwards, about 7 cm. above the articular surface, the line of this fracture in front assuming a spiral direction. On the inner and posterior aspects two longitudinal fissures, nearly parallel with each other, run upwards from the seat of fracture for a distance of 12 cm. 3999

9. A calvaria extensively fractured as the result of a blow on the right parietal eminence. At this spot two fragments are entirely separated, and from it one fissure runs forwards across the frontal bone, and another backwards through the lambda into the left parietal bone. Several smaller fissures radiate from the seat of the injury, some of which are confined to the outer and some to the inner table of the bone.

10. A calvaria in the right parietal bone of which, close to the sagittal suture, is a depressed fracture, involving a circular area of bone about 3 cm. in diameter. The parts are firmly consolidated, the edges of the aperture being smoothly rounded and the surfaces of the depressed bone being marked by furrows and ridges resulting from the union of the different fragments into which it was separated. 5177



## UNION OF FRACTURES.

The specimens from No. 11 to No. 24 are intended to illustrate the general process of repair of fractures. From experiments on animals the following is found to be the ordinary process in simple fractures:—For a short time no change takes place, the broken ends being surrounded by unaltered blood-clot. After this a mass of soft granulation tissue is rapidly formed, chiefly from the periosteum, but also, in some cases, from the surrounding tissues (14). Internally a similar growth forms in the medulla. This is the provisional callus: that from the periosteum is distinguished as the external, and that from the medulla as the internal provisional callus. The callus thrown out above coalesces with that from below the seat of fracture, and there is then a sheath outside and a plug in the medullary canal firmly joining the fractured ends. The callus, at first soft, soon becomes firm, and either fibro-cartilaginous or cartilaginous in structure; and about the second week in dogs, and the third week in man, ossification commences in it, first in the neighbourhood of the old bone to which the new bone is adherent (12). Ossification is complete by about the end of the third week in dogs, and the fifth, sixth, or seventh in man. The formation of the uniting bond between the fractured surfaces of the compact tissue (the definitive callus) does not commence in dogs till the provisional callus is completed, and it is not completely ossified till about the end of the second month. The provisional callus, except that filling up any angle or irregularity, being now no longer needed, is gradually absorbed, and the medullary canal is more or less completely restored. The last process of all is the gradual rounding off by absorption of any irregular point of bone which may be left after union. This is not complete for a year or more.

In man a complete ensheathing ring of callus is seldom seen, and, except in the ribs (which cannot be absolutely fixed in the treatment), it is not common to find true cartilage developed in the process of repair. When the bones are in perfect apposition, and kept at perfect rest, union between the two surfaces of the compact tissue takes place at a much earlier date than that mentioned above. The provisional callus will be found to be formed in such a manner as to fill up any angles that may result from displacement (18). It is least abundant in those fractures in which perfect immobility can be obtained in the treatment. It is scarcely to be recognized in fissured fractures, as in the skull (24).

Compound fractures, when aseptic, unite in a manner identical with that above described. Should, however, the wound become septic, the process of repair is delayed, the amount of granulation-tissue and subsequent bony callus is excessive, and necrosis of the ends of the fragments is likely to occur.

In all early specimens obtained from the human subject it must be remembered that the patient was suffering from some mortal disease or injury as well as from the fracture, and that it is therefore highly probable that repair has proceeded much more slowly and imperfectly than it would have done in a healthy subject.

11. The upper end of the shaft of a humerus in process of repair, after having been recently fractured. No new bone has been produced, either upon the surfaces of the fragments or between their ends, which are held together by a layer of granulation tissue and by the consolidation of the soft parts immediately surrounding them. The stage of repair is that of about the end of the second or beginning of the third week. 3372

12. A longitudinal section of a dog's tibia, injected, which was fractured transversely ten days before the animal was killed. The ends of the fragments lie in accurate apposition, but the line of fracture is plainly discernible. The uniting medium consists of a ring of new tissue (external provisional callus) occupying about 3 cm. of the length of the shaft, and composed almost wholly of finely porous

bone; the medullary canal is occupied, though for a less extent, by similar tissue (internal provisional callus). The sheath of provisional callus is continued without interruption from one fragment to the other, but opposite the seat of injury it has a pearly whiteness, is non-vascular, and consists of fibro-cartilage. Remains of a similar substance may be seen also in the new bone which fills the medullary cavity at the line of fracture; ossification is advancing into the portions of cartilage remaining. No tissue of the same kind intervenes between the fractured ends of the compact wall of the shaft. The periosteum has been stripped from the surface at the seat of repair; it is increased in thickness, and scales of the new bone have been torn away from the ring of external callus, and adhere firmly to the detached membrane. 2894

The process of repair is much more advanced than would be the case in a human subject at a similar time.

13. A longitudinal section of a left humerus which was transversely fractured nineteen days before death. No union has occurred between the broken surfaces; but the ends of the fragments, slightly displaced, are held together by a sheath of new bone (external provisional callus) about 2.5 cm. in length; the irregularity of the latter, and the spaces existing within it, as well as the interval between the fractured surfaces themselves, are due to the disappearance of the softer parts of the connecting medium, the result of drying. The ends of the medullary canal are closed by new bone, the amount of which in the upper fragment exceeds that in the lower, the fracture having occurred below the entrance of the medullary artery. 2635

The patient was a boy, ten years old, who, in a fall from a house, fractured the left humerus, one of his thigh-bones, and the base of the skull.

14. The upper half of a left clavicle which has been divided horizontally to show the repair of a comminuted fracture of the middle of the bone produced 22 days before death. The two main fragments and two separated portions of compact tissue are held together by a considerable mass of soft provisional callus. Ossification has already begun in several parts of the latter, the newly formed spongy bone being most abundant under the periosteum over the posterior aspect of the fragments. Thin layers of new osseous tissue are also discernible on the fractured surfaces of the fragments. 5835

From a man, 23 years of age, who was knocked down in the street and run over, the wheel passing over the left shoulder. He became delirious after the accident and died of bronchitis.

15. The right femur, from a person 15 years of age, fractured obliquely through the junction of its upper and middle thirds, and in which the reparative process is in an early stage. No new bone is present on the fractured surfaces themselves. Both the openings of the medullary canal are occupied by internal callus, which is most abundant in the lower fragment, the fracture being above the entrance of the medullary artery. The external callus is most abundant on the posterior surface of the upper fragment, and in the greater part of the circumference of both fragments the ossification, which has commenced in the angle beneath the raised periosteum, has not yet advanced to the line of the fracture. 3075

16. A longitudinal section of the upper part of a right femur fractured obliquely near the junction of its upper and middle thirds, showing the progress of repair after four weeks. The lower fragment is displaced slightly before, and to the inner side of, the upper. Portions of new bone of a finely porous texture, which have been broken across in the sawing, so that the fragments are artificially separated, exist between the fractured surfaces, and appear to have restored their continuity. The chief part of the new bone, however, projects from the outer surface of



the lower fragment, filling the angle which has resulted from the displacement. A thin layer of similar bone has been formed also for some distance upon the surface of the upper fragment. 188

17. The other half of the same femur, showing more distinctly a layer of porous osseous substance, covering the fractured surface of the compact wall of the shaft, after the latter has become minutely toothed by absorption. 189

The patient, a boy 14 years of age, died from enteritis.

18. A horizontal section of a fractured rib in process of repair, after separation of its fragments.

The uniting medium, composed partly of finely cancellated bone, partly of fibro-cartilage, fills the interval between the fragments and the angles resulting from the displacement, and is continued upon the surface of each of the fragments for the distance of about 2 cm.

The narrow compact walls of the rib are scarcely traceable to the ends of its two parts, becoming confused with the cancellated new bone, across the middle of which, and lying directly between the fractured portions, there is a line of fibro-cartilage into which ossification has not yet advanced; small areas of similar fibro-cartilage are discernible also near the surface. The mode of repair closely resembles that in No. 12. 2886

19. A longitudinal section of a rib which has been transversely fractured. The fragments are held in accurate apposition by an encircling ring of porous new bone, and by a layer of similar osseous substance about 3 mm. in thickness, which has been formed between them. 3203

20. Portion of a fractured rib, from some large animal, the fragments of which, slightly displaced, are enveloped by a thick ring of newly-formed porous bone.

21. A right tibia and fibula. The former has been obliquely fractured towards the lower end of its shaft; a slight ridge resulting from displacement of the fragments alone remains to mark the line of injury. The fibula has not been broken. 3167

22. Longitudinal sections of a left tibia and fibula which have been obliquely fractured near the middle of their shafts at least six months before death, showing commencing restoration of the medullary canal by thinning and subsequent disappearance of the lamellæ forming the cancellated tissue (internal provisional callus) which occludes it. 3123

23. A longitudinal section of part of the shaft of a femur in which a fracture has at some time occurred. Externally there is no trace of the injury beyond an increase in the natural curvature of the shaft forwards. The compact tissue of its wall, which is increased in thickness along the back of the curvature, is uniformly continuous, and the medullary canal is nearly restored, a thin septum of cancellous tissue alone remaining across it. 2636

24. The right half of a skull in which a fissure 9 cm. long, reaching from the parietal eminence to the root of the zygoma, has, for the most part, healed; in the rest of its extent the edges of the fissure have been smoothly rounded, and the interval between them increased, by absorption.

On the internal aspect, except for the distance last mentioned, no trace of the injury remains.

## DEVIATIONS FROM THE NORMAL PROCESS OF REPAIR OF FRACTURES.

*Malposition.*—Any variety of displacement may persist during the repair of a fracture as the result of imperfect treatment. It may be angular (27), longitudinal (25), or rotatory (29).

*Ununited Fracture* results from failure in the formation of an osseous bond of union between the fragments. It includes the following varieties:—

*Fibrous Union*, arising from some general condition of the patient; from want of perfect rest in the treatment; from loss of substance by necrosis of the fragments (31); or from a wide separation of the fragments (30).

*False Joint.* The ends of the fragments are rounded, and the medullary canal (if the fracture be in the shaft of a long bone) is closed by a layer of dense smooth bone. The fragments are held together by a capsule of dense fibrous tissue passing from one to the other, but not between the fractured surfaces (35). Sometimes one end is rounded and the other cup-shaped, so that the whole resembles a ball-and-socket joint. False joint results from causes similar to those producing ordinary fibrous union, especially want of perfect fixation (36).

*Independent Repair.* The ends of the fragments become smooth and rounded, and the medullary canal closed, but no bond of union forms between them.

*Complete Want of Repair* is very unusual. It is seen most commonly in cases of spontaneous fracture.

*Suppuration and Necrosis.* Necrosis of the ends of the fragments occurs almost exclusively in compound fractures in which suppuration has occurred at the seat of injury (40, 42). Suppuration is an extremely rare complication of simple fractures; it has, in some instances, seemed to be the result of infection from some distant focus of suppuration (37, 38). Necrosis delays the repair of a fracture, and may be followed by fibrous union.

*Excessive Formation of Callus* arises usually from want of rest during the process of repair (47). In very rare instances a true *Hypertrophy of Callus* takes place, which may closely resemble the formation of a tumour (48, 49).

*Tumour Formation* after fracture is extremely rare. It must not be confused with hypertrophic conditions of the callus, nor with the presence of a tumour in the bone preceding and not following the occurrence of fracture. Tumours developing at the seat of a fracture may be bony, cartilaginous, or sarcomatous.

25. A longitudinal section of part of a tibia fractured through its shaft, the fragments of which have united after great displacement, their ends overlapping for a distance of nearly 5 cm.; these are smoothly rounded, and the opened medullary canal is closed by a layer of compact osseous tissue. The connecting medium consists of a plate of bone, 6 mm. thick, cancellated in its centre, but otherwise formed by dense compact tissue, continuous with the walls of the shaft, which are readily traceable to the end of either fragment.

A thin layer of bone covers the surface of each of the fragments for a distance of about 7 cm. 2969

26. A longitudinal section of a right tibia and fibula, which have become united together at the seat of a fracture by a bridge of bone composed almost entirely of dense, compact tissue, continuous with that forming the walls of their shafts.

The lower fragment of the tibia is displaced slightly outwards, and the angles resulting from the displacement are filled with new osseous substance. 3168



27. A longitudinal section of a femur fractured somewhat obliquely above the middle of its shaft, in which union has occurred after tilting forwards of the upper fragment and displacement upwards of the lower.

The ends of the fragments are smoothly rounded, and held together by a bond of osseous tissue, cancellated in its centre, but otherwise compact, which fills the angles resulting from the displacement. The walls of the overlapping parts where union has occurred are no longer traceable, their tissue having become cancellated and continuous with that forming the central part of the callus.

3176

28. A plaster cast of the right thigh and adjacent parts, showing deformity after the repair of a fracture above the middle of the shaft of the femur: the fragments have united almost at a right angle, causing a sharp projection on the anterior and outer aspect of the limb.

6260

The patient was a boy æt. 12 years; the fracture had been treated with a long splint for 4 weeks, followed by a starched bandage for 6 weeks. The limb was shortened to the extent of 6 cm., and presented the deformity shown in the cast. Three months later the bony union was broken down and weight-extension applied, followed by splints for two months. The shortening was reduced to 12 mm.

29. A right radius, repaired after a fracture above the middle of the shaft. There is considerable rotatory displacement, so that when the upper fragment is fully supinated the lower fragment occupies the mid position between pronation and supination. The amount of callus is excessive, and from the upper and inner angle of the lower fragment the appearance of a projecting mass of spongy bone suggests that it lay in contact with a similar projection from the ulna.

7132 A

30. A vertical section of a patella, which has been fractured transversely below the middle. The fractured surfaces are separated to the extent of 4 cm., and are held together by a broad fibrous band which at its extremities is continuous with the aponeurosis covering the front of the fragments.

6299

The specimen was obtained from a man æt. 57, who died of carcinoma of the pancreas and intestinal obstruction 2 years after the bone had been broken.

31. A lower jaw in which, after a fracture through the right half of its body, considerable loss of substance has occurred, probably as the result of necrosis. The only tooth remaining in the right half of the jaw is the canine, and between this tooth and the angle the bone is replaced by a band of dense fibrous tissue holding together the fragments and continuous with the thickened periosteum on them. A narrow strip of bone remains embedded in the outer surface of the fibrous band. The space originally occupied by the two incisor teeth of the right side and the mesial one of the left side is represented by an interval of merely 8 mm. between the right canine and the left lateral incisor. The curvature of the left half of the jaw is much reduced.

5216

32. A longitudinal section of the lower end of a tibia, five and a half months after the occurrence of fracture. A layer of white filamentous tissue, about 2 mm. in thickness, intervenes almost uninterruptedly between the fragments, passing in front between their compact walls to reach the surface, where it is continuous with the periosteum. Posteriorly, however, in the plane of section, the compact tissue is continuous through the medium of dense cancellated bone. As seen externally the line of fracture is very oblique, and passes from within outwards and upwards; and the surface of the fragments is continuous by bone at parts only.

3733

33. A left tibia and fibula, in longitudinal section, which have been at some time fractured near the junction of their middle and lower thirds; the lower fragments are



bent backwards almost to a right angle. No osseous union has taken place; but the ends of the fragments, slightly enlarged, so as externally to bear some resemblance to a natural articulation, lie close together, and are so interlocked that little movement is possible between them. The line of fracture is occupied by soft fibroid tissue, and is readily traceable. The ends of the medullary canal are closed by a layer of compact bone, and the canal itself, in the upper fragment, is filled for about 2.5 cm. with cancellated osseous tissue. The bones generally are atrophied, a mass of small lobules of fat occupying the place of their cancellated structure. 5276

34. A dissection of the opposite limb, in which a fracture of both bones occurred at the same time, and in much the same situation, as in the preceding specimen; the mode of repair is also similar. 5276

From a girl *æt.* 15, who died with a large enchondromatous tumour of the shoulder which appeared to have arisen in the neck and body of the scapula, and to have completely separated and ultimately broken up the osseous plates between which it grew. Its structure was enchondromatous, in parts ossifying, and the growth extended into the adjoining blood-vessels. There were secondary tumours in the uterus and liver.

For further details see an account of the case by A. Bruce, Esq., in the Transactions of the Pathological Society, 1867.

35. A left humerus, transversely fractured through the middle of the shaft. The broken ends, rounded and covered for the most part with fibrous tissue, lie in a cavity which is bounded by a thick capsule of the same tissue, to which the superjacent soft parts appear to have been intimately adherent. The cavity is lined with a smooth false membrane; its interior is in parts fasciculated, and gives attachment to clusters of small pedunculated bodies.

The end of the upper fragment is slightly concave, that of the lower convex; with the ligamentous smooth-walled capsule around them they form a kind of ball-and-socket joint. 4240

36. Plaster cast of the right forearm, showing considerable deformity resulting from a fracture of both the bones. No osseous union had occurred, and a false joint was present at the seat of fracture. 6449

The patient was a healthy man *æt.* 25. The fracture had been treated in the first instance with a single internal rectangular splint. Fourteen months after the accident the false joints were excised and the bones wired; suppuration followed, and the wires separated. The final result was good.

37. The upper part of a left humerus, fractured transversely about the junction of the upper and middle thirds. A distance of about 3 cm. intervenes between the ends of the fragments, owing mainly to a tilting forwards of the upper one; the lower fragment is displaced for an equal distance upwards and outwards. A portion of the wall at the end of each fragment has undergone necrosis, and is surrounded by a distinct ulcerated groove.

A flattened process of bone, about 3 cm. in length and 2 cm. in breadth, passes from the upper fragment immediately above the necrosed part to a point on the lower fragment immediately below that portion of its wall which has suffered necrosis; in this situation a false joint has been formed between the process of new bone and the side of the lower fragment.

The patient, a man 25 years of age, was run over by a waggon, and sustained, in addition to the injury of the humerus, fractures of the lower jaw, the right thigh-bone, and three ribs. He died of septicæmia two months afterwards. Before death suppuration occurred at the seats of all the fractures. [Mr. Marshall's *Case-book*, 1872, p. 309.]

38. The right clavicle of a man 72 years of age, in which no osseous union has occurred after a fracture. Portions of the ends of the fragments have become necrosed,

and are surrounded by a commencing groove of demarcation. The ends of the fragments themselves lie within a cavity limited by a layer of fibrous tissue about 2 mm. in thickness, firmly attached to the living bone, on which new osseous substance has at some parts been deposited. 3707

The patient fell on his shoulder, striking his head against an iron bar. On admission to the hospital, seven weeks after the accident, there was a large swelling over the middle of the clavicle, and another, as large as an orange, in the middle line of the head; the latter swelling was opened, erysipelas supervened, and the patient died. After death, at the site of the head-injury, there was found necrosed bone; the swelling over the clavicle contained pus. The flocculent contents of the cavity are perhaps the remains of a commencing fibrous union broken down in the abscess.

39. The tibia and fibula of a dog, across the upper part of the shafts of which a compound fracture occurred. Union has been prevented by necrosis of the ends of the fragments. The necrosed portions have for the most part been detached, the ends of the fragments being reduced in size, and their surfaces rendered uneven by ulceration; immediately beyond this an irregular ring of new and very vascular bone surrounds the fragments, but none has as yet been produced upon the surfaces mentioned. 3277

40. A right tibia and fibula, fractured obliquely, the former about 10 cm. above its lower end, and the latter about 7 cm. from its upper end. In the tibia two converging fissures pass upon the outer aspect from the line of fracture, meeting a short way from the ankle-joint and running into another, by which the anterior projection of the hollowed surface which receives the fibula is almost separated; the ankle-joint, however, is not opened. The margin of the upper fragment of the tibia has undergone necrosis, the extent of which is defined by a groove of demarcation surrounding it, and by the growth of an irregular ridge of porous new bone upon the surface of the living shaft beyond. On the inner side of the lower fragment a narrow strip of the compact wall has also become necrosed, an ulcerated groove, beyond which the bone is covered with a ridge of newly-formed osseous tissue, accurately marking its limit. The surface of the shaft, for a short distance below, is obscured by a thin layer of new bone, which is continued round the outer aspect, and bridges over the upper ends of the fissures in this situation. In the fibula scarcely any indication of repair exists, but the detached portions have retained their vitality; one of these is fixed apart to show a thin layer of very vascular osseous substance covering its fractured surface. 2889

The patient, a man æt. 36, met with the injury by leaping from a eorn-stæck; the fracture of the tibia was compound. He died of dysentery four weeks after the accident.

41. A left tibia and fibula fractured obliquely about 5 cm. above the ankle-joint. A portion of the tibia, 6 cm. in length, has been completely separated after necrosis. The upper end of the detached portion is sharply pointed, its surface smooth, and its whole aspect that of bone recently fractured; in its lower part the surface has been rendered irregular by the ulceration which has attended its separation. Posteriorly, a second portion has suffered necrosis and has also separated. The dead portions are incompletely surrounded by irregular nodulated masses of new bone, by which the union of the fragments is effected; similar bone has been formed upon the opposite surface of the fibula and is continuous with that formed upon the tibia. The overlapping fragments of the fibula are united by osseous tissue, resembling in texture that which has been produced around a second fracture, about 7 cm. below its upper end, and in which union has taken place without displacement.

Both the fractures of the fibula were apparently simple, whilst that of the tibia was compound. 202



42. A left femur in which an oblique compound fracture occurred near the junction of its middle and lower thirds. The overlapping fragments have become united after the separation of a necrosed portion from the lower fragment, 14 cm. long, and of a smaller necrosed portion from the upper. The larger sequestrum, which includes nearly the whole of the compact and part of the cancellous tissue of the shaft, is almost concealed on the inner side by a broad mass of new bone with a coarsely nodulated surface, which bridges across the interval so as to hold the fragments firmly together; through an aperture towards its front and lower part the necrosed portion of the upper fragment is visible. On the outer aspect the new bone is not so abundant, being limited to a slender bridge connecting the fragments above and two masses inferiorly, the anterior of which unites the fragments in this situation, whilst the posterior forms part of the shell surrounding the larger sequestrum. 1051

Death occurred three months after the injury.

43. Parts of the radius and ulna, together with the humerus, of a pig which was fed with madder after a compound fracture of the first two bones near the radio-ulnar articulation. The fragments of the radius have become necrosed, the lower portion lying partly within a cavity lined with soft granulation-tissue, but chiefly within a shell of new bone.

The ulna has been fractured a short distance below the olecranon; a thick transverse ridge of new bone marks the line of union of the two parts. 240

44. Part of the shaft of an ulna obliquely fractured, in which union has occurred after slight displacement of the fragments. The fragments, which are considerably thickened, are firmly held together by strong bridges of bone. A considerable part of the cancellous tissue of both fragments has undergone necrosis and is in process of separation. On two aspects of the bone the necrosed portion is exposed in the line of the fracture, the cavity in which it lies being lined by granulation-tissue. 1058

45. The upper third of a left humerus from which a part of the shaft on the outer aspect, perhaps detached by a fracture, has been removed after necrosis. Two flattened bridges of new bone pass between the surfaces above and below. 3706

46. Portions of bone detached in a fracture of the great trochanter and rendered irregular by the formation of finely reticulated new bone on their surfaces, showing them to have retained their vitality. The new bone exists chiefly upon their fractured surfaces, the lamellæ of which are, for the most part, coated with the new osseous tissue, after having been reduced to delicate rods by absorption. 2893

47. A left femur which has been fractured below the small trochanter: there is considerable angular deformity, and the lower fragment has been drawn up in front of the upper. The fracture appears to have been comminuted, and an unusually large amount of callus has been thrown out in the process of repair. In their present condition the two fragments are separate, the callus probably having been fractured in the preparation of the specimen.

48. A vertical section of the left leg-bones and foot of a child. The tibia is markedly curved forwards in its middle part, which is occupied by a considerable fusiform swelling; the enlargement is composed of soft cancellous bone which can easily be cut with a strong knife, and which in the recent state was clearly marked off from the old bone by the redder colour of the latter. In the concavity of the curve above and below the swelling there is a layer of compact bone beneath the periosteum posteriorly; but no such layer exists in front. At no part of the swelling are areas of soft tumour-like tissue to be distinguished. The outer

surface of the swelling is smooth and regular. At a short distance below its middle the fibula is bent forwards, and presents a rounded enlargement which externally is deeply grooved transversely. The enlargement is in no way connected with that of the tibia, and its cut surface presents a denser appearance. 7910

*Microscopic Structure.*—The tissue forming the enlargement of the tibia presents narrow anastomosing trabeculae of bone enclosing spaces filled with cellular and fibrillated tissue: the trabeculae contain bone-corpuscles but no Haversian systems, and are in parts fringed with one or two layers of osteoblasts, and in other parts are indented by Howship's lacunae containing multinucleated osteoclasts.

From a female child, æt. 5 years, who at the age of 1 year had fallen from a chair and injured her leg so as to disable her for a fortnight. Swelling of the limb was first noticed a year and a half after the injury. The swelling increased, and four years after the injury the leg was amputated with the idea that the swelling was an ossifying sarcoma. The specimen is in all probability an example of hypertrophied callus following a fracture of the tibia and fibula. (See Trans. Path. Soc. vol. xxxvi. 1895, p. 388.)

49. The right tibia and fibula of a child, the former being divided vertically in its whole length and the latter in its lower part only. The tibia presents an undue curvature, which affects its whole length, and has its convexity directed forwards and inwards; the middle third of the bone is enlarged, the enlargement being most marked at the junctions of the middle with the upper and lower thirds, so as to produce two swellings on the bone. The lower of these swellings is much the larger, and immediately below it distinct mobility is present, and the curvature is more marked than at any other part of the bone. The inner surface of the tibia in this position is marked by a recent incision into its substance. The section of the bone presents the following appearances:—the upper extremity and the upper part of the shaft are normal; from the anterior surface of the bone 2 cm. from the epiphysal cartilage a bar of compact bone 5 mm. in thickness passes downwards and backwards to join the posterior compact wall. From this level downwards to that of the fracture the interior of the bone is occupied by a dense osseous substance, crossed by a second ridge of compact bone similar to that above described. Especially in front, the compact wall of the shaft is in parts thinned or wanting. At the level of this fracture immediately below the lower enlargement, the substance of the shaft is almost completely replaced by soft tissue, which invades the substance of the lower fragment for a distance of about 1 cm. The lowest 2 cm. of the shaft and the lower extremity of the bone are normal. The fibula in its upper part is normal. In its lower fourth the shaft presents an irregular fusiform enlargement and a marked curvature directed inwards. The section shows that a fracture has at some time occurred at a distance of 2 cm. above the lower epiphysal line. Union has occurred, allowing a slight amount of movement. 7249

*Microscopic Structure.*—In the tibia, the soft substance uniting the fragments consists of dense white fibrous tissue. The enlarged portion of the shaft is composed of irregular trabeculae of bone separated by spaces occupied by somewhat loose and cellular connective tissue. In many places a layer of osteoblasts lies in contact with the trabeculae, in others small groups of multinucleated cells are present; the connective tissue is traversed by blood-vessels, most of which are wide and thin-walled, but some narrow and having a distinct muscular coat. Normal marrow-tissue is not present. The enlarged portion of the fibula has a similar structure, except that, in place of the dense fibrous tissue at the line of fracture, there is a zone of cartilage, the surfaces of which have been partly converted into bone.

From a male child 3 years of age, in whom bending of the tibia began at the age of 5 months. The limb was treated with splints for 12 months without any improvement resulting, and the patient was afterwards admitted to St. Mary's Hospital, where the leg was straightened and put in plaster of Paris for 1 month. Bending of the bone rapidly recurred. Three months later the patient was operated on at Bedford, and the leg somewhat straightened and put in plaster of Paris; bending of the bone returned gradually after the plaster was removed. Nine months after the last operation the patient was admitted to U. C. H., and it was decided to perform cuneiform osteotomy, but on cutting through the bone it was found to contain soft growth. Amputation was performed a week later. Five years after the amputation the patient was reported as being in good health. (Mr. Godlee and Mr. Pollard's *Case-book*, 1894, vol. i. p. 58.)



## SPONTANEOUS FRACTURES.

Spontaneous fractures, or such as occur from causes insufficient to break a healthy bone, may result from general conditions which lead to weakening of the bones, or from local disease of the bone at the seat of fracture. Amongst the most important general conditions which are recognized as causes of spontaneous fracture are *mollities ossium*, rickets, certain diseases of the nervous system—such as general paralysis, syringomyelia, and *tabes dorsalis*—and *fragilitas ossium*, a condition sometimes inherited and characterized by a more or less marked liability to the occurrence of fractures from very slight causes (50). Of the local causes which may so weaken a bone as to occasion spontaneous fracture, the most important are caries, necrosis, and new growths. Caries may cause such a degree of loss of substance in a bone that the remaining portion is incapable of withstanding even a slight degree of injury (52). The loss of substance following necrosis may act in the same way, but in this case fracture has more often been known to involve the involucrum of new bone which forms around the sequestrum (51). Of the tumours of bone occasioning spontaneous fracture, one of the most common is secondary carcinoma (55, 56), but the same accident not unfrequently occurs as the result of the growth of a sarcoma either centrally or beneath the periosteum (54). In some instances spontaneous fracture results from malignant disease of a bone when the tumour is still quite inconsiderable in size and incapable of detection through the overlying soft parts. In many forms of spontaneous fracture repair is either incomplete or wanting (50); in some instances, however, perfect union takes place (50), and even when the fracture has resulted from the growth of a malignant tumour some attempt at repair may be recognizable (55).

50. The right humerus of a young person, in which a fracture near the middle of its shaft has united by bone, a fusiform enlargement indicating its seat, and in which a second fracture about 5 cm. lower down has subsequently occurred. At the seat of the second fracture no osseous union has taken place between the fragments, the lower of which is tilted backwards, its upper end being displaced forwards; the fragments, however, are held together by a thick capsule of very close fibrous tissue, a small cavity with a smooth interior existing between them.

Towards the upper end of the humerus a third fracture has recently occurred; the shaft of the bone at this part is slightly enlarged by a layer of very soft spongy osseous substance. The whole bone is soft, and at its upper end, where large spaces have resulted from absorption of the cancellous tissue, it may readily be cut with a knife: the compact tissue forming its wall is also diminished in thickness.

191

The lowest of the fractures was occasioned by the patient resting on his arm whilst turning in bed.

51. The leg-bones and lower part of the femur and the patella of the right side. Extensive necrosis has occurred in the lower part of the shaft of the femur, two sequestra, which together include the whole compact tissue of the original shaft for an extent of nearly 10 cm., being imperfectly included in an involucrum of new bone. The lower ends of the sequestra project through an opening in the front of the involucrum, and the upper ends are exposed in a large opening on the inner aspect. The shaft of the femur above the necrosed portion is solid and sclerosed. At a level of 3 cm. above the condyles, the bone is sharply bent nearly to a right angle, and presents the appearances of a fracture which has become firmly consolidated; and immediately above the sequestra the shaft presents a second much less marked angular deformity. Bony ankylosis has occurred between all the articular surfaces of the knee, the joint being fixed in a position of extension. The fibula forms a long bow-like curve behind the tibia, and the middle part of the bone is remarkably flattened, its outer portion being converted into a

thin sharp-edged plate. The extremities of the fibula retain their normal relation to the tibia.

The course of events which has resulted in the condition present in the specimen may probably be summed up as follows:—Acute necrosis of femur, suppuration of knee-joint, fracture of involucrum, osseous ankylosis of knee, arrested growth of upper epiphysis of tibia, and curvature of the fibula.

52. The head of a left femur removed by operation at the seat of a fracture through the neck. The superficial parts of the neck are eroded, and the thickness of the bone is in consequence greatly reduced.

The fractured surface appears as a quadrilateral concavo-convex area 2 cm. across; it is smooth and sclerosed. The erosion of the neck extends up to, and in places involves and undermines, the edges of the cartilage. The depression for the round ligament is increased in size by caries. The articular cartilage is in many parts covered by a thin adherent membrane. In the section the bone, especially in the neck, is seen to be sclerosed.

7451

The patient, a lad of 17, fell whilst skating, and presented the signs of a fracture of the neck of the left thigh-bone. In spite of treatment no union had occurred at the end of 4 months. Slight lameness had been noticed for several weeks before the accident, and a younger sister was at the time under treatment for hip-disease. A good result followed the removal of the head of the bone. (Clin. Soc. Trans. vol. xxix. 1896, p. 188.)

53. A plaster-cast of a left forearm and hand, showing the deformity resulting from a spontaneous fracture of the shaft of the radius which followed the growth of a gumma in the bone. There is a prominence on the anterior aspect of the forearm below the middle and a slight deviation of the hand to the radial side.

7937

S. K., a married woman, æt. 48, was admitted into U. C. H. under the care of Mr. Godlee on March 1st, 1880. For some months a swelling had been noticed just below the middle of the left radius; the tumour was most prominent anteriorly; it was firm, tender, and painful at night; in the position of the swelling crepitus could be felt, and the head of the radius did not move when the lower end of the bone was rotated. There was a small lump on the right ulna 5 cm. below the olecranon and a puckered scar over the angle of the lower jaw on the left side. The swelling of the radius was thought to be a tumour, and the affected part of the bone was excised. The tumour measured 6 cm. by 3.5 cm., the outer part looked like immensely thickened periosteum, and the interval between the fragments of the fractured bone was occupied by "softish fibroid tissue." Primary union occurred in the wound, and a leather splint was applied to the limb. (Surg. Reg. Rep. 1880, p. 46, No. 864.)

54. A right humerus in which a fracture of the upper third of the shaft has resulted from the growth of a tumour in the bone. The fracture runs very obliquely downwards and outwards, so that the lower end of the upper fragment is thin and pointed; the fractured surfaces are covered with a layer of inflammatory exudation. A large lobulated tumour projects from the inner aspect of the bone at the upper level of the fracture, and is much more extensively connected with the upper than with the lower fragment. Anteriorly the growth extends upwards to the anatomical neck, and on the fractured surface of the upper fragment the growth is seen to occupy the interior of the bone. The size of the external growth and the absence of expansion of the bone indicate that the tumour commenced subperiosteally, and invaded the medulla secondarily.

6321

*Microscopic Structure.*—The growth is a spindle-celled sarcoma.

From a man, æt. 35, admitted under the care of Mr. Heath in 1887. A painful swelling of the right arm had been noticed for 5 months, and inability to move the limb had suddenly occurred whilst the man was attempting to box his son's ears. On admission, the existence of fracture and tumour was obvious. Amputation was successfully performed at the shoulder-joint.

55. A right femur fractured transversely at the junction of the upper and middle thirds, and imperfectly repaired after displacement of the upper end of the lower fragment behind and to the inner side of the upper fragment. At the seat of fracture the interior of the bone is occupied by new growth, which projects from



the interior of each fragment so as partly to overlap their extremities and fill up the intervals between them. A lobulated projection of the growth more prominent than the rest is seen on the posterior surface of the upper fragment. The two fragments are rigidly held together by bony callus, which can be seen imperfectly covering the mass of growth which surrounds the fracture. A second small deposit of growth occupies the upper part of the posterior intertrochanteric line. 5576

From a middle-aged woman who died with extensive secondary deposits of carcinoma following a primary growth in the breast. The tibia from the same case is preserved in No. 745.

56. A left humerus in longitudinal section showing two fractures, one of which has been completely and the other incompletely repaired. The upper of the two fractures, which is situated a short distance below the middle of the shaft, is surrounded by a considerable mass of callus, which is but loosely connected with the surfaces of the fragments. The compact tissue in the neighbourhood of the fracture is coarsely reticulated, especially in the upper fragment. The second fracture, situated about 3.5 cm. below the preceding, is firmly consolidated after slight deformity, and the medullary canal is filled with spongy osseous tissue. Posteriorly the compact tissue is thin and shows no solution of continuity; anteriorly, however, the line of the compact tissue is broken, and a mass of spongy bone fills in the angle between the fragments. In the rest of its extent the shaft is for the most part normal in appearance, but at the upper extremity the bone is much rarefied. 2632

From a woman who was extensively affected with cancer. The recent fracture occurred whilst the patient was turning in bed. Probably the bone was the seat of secondary cancerous deposits.

#### GUNSHOT FRACTURES.

The chief peculiarities of gunshot fractures are that they are necessarily compound, that they are usually much comminuted (73, 79), that the fragments are sometimes carried to a considerable distance from their normal situation, and lastly that they are often accompanied by most extensive fissures in the injured bone (80), sometimes extending into the neighbouring joints. In a gunshot wound of a flat bone the comminution is more extensive towards the aperture of exit (61). In addition to the apertures of entry and exit caused by the passage of a bullet through the skull, sutures are often burst open and extensive fissures are produced (61). The old round bullets caused less severe comminution and far less extensive fissuring than the modern conical ones.

The damage produced in bones by the cylindro-conical bullets of the modern small-bore rifles varies with:—

The *Range*: the shorter the range, and therefore the greater the velocity, the more marked the fissuring and “explosive” effects (84, 85).

The *Character of the bone struck*: in dense, compact bone, the comminution and fissuring are more extensive than in cancellous bone.

The *Direction* in which the bone is struck: the more nearly a bullet strikes the greatest diameter of a long bone the greater is the damage to the bone. A bullet striking a bone at a tangent may cause a groove, but usually also produces fissures.

Superficial necrosis may occur as the result of a glancing shot which does not cause fracture (69).

57. Three bullets of the period of the Franco-German War, 1870–71.  
Needle-gun. Chassepot. Bavarian.

5739

58. Two bullets. Martini-Henry. Lee-Metford.

8137

59. Fragment of a shell extracted from the thigh of a soldier in the Franco-German war.

5740

60. Left half of the skull of a Carlist soldier (1833-40), in which a fracture of the frontal bone above the external angular process has been occasioned by a round bullet. An irregularly rounded opening exists in the bone, and around its upper half the external table is concentrically fissured and depressed. Viewed from within, the damage to the inner table is seen to involve a larger area than that to the outer, and at the posterior border of the opening the inner table is sharply depressed. No fissures radiate from the position of the fracture. 3237
61. The skull of a man who shot himself through the roof of the mouth. The bullet, after traversing the hard palate and the front of the body of the sphenoid bone (the olivary eminence and right anterior clinoid process of which have been completely destroyed), has perforated the roof the skull a short distance behind the coronal suture and slightly to the right of the median line. Owing to the direction of the force from within, the injury sustained by the outer table at the aperture of exit is greater than that received by the inner, the aperture in the former being everywhere more extensive than that in the latter: the margin of the perforation, as viewed from the exterior, is bevelled. Several fissures radiate from the margins of the aperture and are continuous with corresponding fissures in the outer table of the detached fragment itself. The most extensive fissure on either side passes through the temporal region to the base of the skull. Some of the smaller fissures are confined to the external table. 4971
62. The upper part of a skull fractured by the combined action of a bullet and water fired into the orbit from a Prussian needle-gun by a soldier who committed suicide. The aperture of exit is situated about the posterior and upper part of the left parietal bone. As in the preceding specimen, the aperture in the external table is everywhere larger than that in the internal. Fissures produced by the rending action of the water extend in all directions through the bones, especially those of the side corresponding with the injury. The base of the skull and some of the bones of the face were also extensively fractured. 5214
63. A chronic cerebral abscess removed entire by operation. It consists of a thick-walled ovoid sac, 3 cm. in length, part of which has been torn away at one extremity. The cavity is lined with granulation tissue, and in the rest of its thickness the wall is composed of brain substance. A distorted bullet is also preserved in the specimen; it was adherent to the outer surface of the inner extremity of the abscess sac. 8005

From a man who received a gunshot wound of the head in the neighbourhood of the left motor area. Subsequently double optic neuritis, spasms and paresis of the right side of the body, and swelling at the site of the wound occurred. The wound was opened up by Mr. Horsley, and the abscess sac exposed: the wall of the latter, having been firmly seized with forceps on either side, was drawn out forcibly from the brain, together with the bullet adhering to its deep surface. The patient recovered.

64. The cervical vertebræ, with part of the pharynx and soft palate, from a man who fired a pistol into his mouth. The bullet has perforated the pharynx to the right of the middle line and passed through the body of the axis, from which it has detached an irregular fragment and displaced it backwards over the right side of the arch.

65. The tongue and larynx from the preceding case; the former has been for the greater part of its length traversed by the ball.

The patient died on the third day after the injury. There was complete motor paralysis of the right arm and leg; sensibility to pain was diminished in the left and increased in the right upper and lower extremities. On the trunk sensation was normal as low as the nipples, below which it was increased on the right and diminished on the left side. The sphincter ani was paralyzed, and there was retention of urine. The temperature of the right half of the body was higher than that of the left. After death the bullet was found lying between the arches of the atlas and axis, close behind the vertebral artery, which was uninjured. On opening



the dura mater, which was not lacerated, the spinal cord was apparently uninjured, but a section showed a bruised condition resulting in capillary hæmorrhage, involving only its right half. (From a report to the Clinical Society by Sir Wm. Gowers, Nov. 10th, 1877.)

66. The fifth, sixth, and seventh cervical and the first dorsal vertebræ. The body of the last cervical vertebra has been fractured by a round bullet. The cavity in which the bullet was found after death is separated from the spinal canal by a very thin layer of bone. The cancellous tissue of the adjoining vertebræ has been exposed at their edges by ulceration, and thin patches of minutely porous new bone are scattered irregularly on the front of the other vertebræ. 5212

The bullet entered the posterior triangle of the neck on the left side, and passed forwards and inwards behind the carotid artery, jugular vein, and œsophagus till it reached the spinal column. The patient died of pyæmia.

67. A first lumbar vertebra and a portion of the seventh rib, fractured by a bullet. The bullet, entering at a spot below and outside the right nipple, passed obliquely through the seventh rib, from which it carried off the portion shown in the preparation; it then perforated the right lobe of the liver, lodging the fragment of rib in its substance, and finally struck the body of the first lumbar vertebra, the cancellous tissue of which has been crushed. 5211

The bullet was afterwards passed by the rectum, having made its way by ulceration into the ascending colon.

68. A vertical section of the eighth, ninth, tenth, and eleventh dorsal vertebræ, showing the effects of a pistol-shot. A portion of the body of the tenth vertebra, detached by the bullet, has been forced backwards and inwards so as to project within the spinal canal, in which situation it must have compressed the spinal cord. On the right side there is a circular aperture made by the ball in front of the costo-vertebral articulation, small portions of bone, together with a piece of the clothing, having been carried into the track of the wound. 3349

The injury was received in the last fatal duel fought in this country, in 1843.

69. A left clavicle, scapula, and upper part of the humerus, showing the effects of a gunshot injury. The bullet struck the anterior border of the clavicle, the most prominent part of which is in process of exfoliation, and passed through the shoulder-joint, carrying away the neck and glenoid cavity of the scapula, together with the adjacent parts of the axillary border and coracoid process, and bruising the head of the humerus; it ultimately escaped behind and to the outer side of the shoulder. The articular surface of the head of the humerus has a worm-eaten appearance from ulceration. 5220

The patient died of pyæmia.

70. The upper part of a left humerus, with the adjacent parts of the scapula and clavicle. Bony ankylosis has followed a gunshot injury involving the shoulder-joint. A fracture through the upper part of the shaft of the humerus has repaired with considerable deformity, and the normal outlines of the upper extremity of the humerus and of the glenoid cavity are obscured by deposits of new bone and probably by the separation of sequestra. A bridge of bone unites the acromion to the humerus, and irregular deposits are present on the clavicle, and in the supraspinous fossa, where a small fragment of lead is firmly impacted. 5486

From a subject in the dissecting-room.

71. The upper end of a right humerus in the head of which a round bullet has lodged, after splitting the head into fragments and detaching its greater part; no fissures are traceable downwards into the shaft. 1059

72. A left humerus fractured through the middle of its shaft by a bullet from a Prussian needle-gun, which entered the limb on the outer side and comminuted the bone for a distance of 5 cm. Some of the detached fragments were removed during life; those shown in the preparation were found, with the bullet, lodged in the muscles on the inner side of the arm; upon the outer or periosteal surface of each of the fragments new bone has been formed in varying quantity proving them to have retained their vitality. A considerable portion of the extremity of each of the main fragments has undergone necrosis, the extent of which is in each indicated by a shallow ulcerated groove. Of the smaller fragments also small portions of the edges have become necrosed, the commencing separation of which is shown by the grooves around them.

A fissure runs downwards for about 4 cm. in the inner wall of the lower main fragment. 5216

73. A left humerus, the shaft of which is comminuted as the result of a gunshot wound inflicted three months before death. From its lower half a portion of the wall at the seat of fracture has been almost separated after necrosis. The largest of the detached fragments also bears evidence, in the toothed condition of its lower margin, of its separation having been completed by a vital process. The numerous smaller fragments are new formations, and have probably been accidentally detached from the living bone in the neighbourhood of the sequestra. 1915

The bullet entered the pectoralis major, which was extensively exposed by subsequent ulceration, and passed through the arm, fracturing the humerus, as shown in the specimen. Extensive suppuration ensued beneath the integument, and the wounds remained unhealed. Amputation was not performed.

74. The bones of a right elbow-joint which has been traversed by a conical bullet. The bullet entered from the front, carried away the coronoid process of the ulna and then passed through the joint, completely detaching the olecranon. The shaft of the ulna below has also been fissured along the front, and a fragment, the surface of which is irregularly coated with new bone, lies loose behind the radio-ulnar articulation. A sequestrum is in process of separation from the upper end of the ulna, and the cancellous bone beneath the articular surfaces of the humerus and radius is extensively exposed. 5215

Death occurred from pyæmia.

75. The bones of a right elbow-joint extensively comminuted by a bullet. A layer of new bone has been formed on the periosteal surface of the several fragments. The articular surfaces of the bones have been rendered uneven by ulceration. 5217

Amputation was performed about fourteen days after the receipt of the injury.

76. A left radius and ulna, the upper extremities of which have been separated from their shafts by a gunshot injury. Both the bones are comminuted at the seat of fracture. The cavity of the joint has communicated with the wound by a fissure leading upwards through the coronoid process of the ulna.

Most of the detached fragments have retained their vitality, their smooth outer surfaces being, as in the preceding specimen, obscured in varying degrees by a layer of new osseous tissue.

The articular surface of the ulna, and in a less degree that of the radius, is irregularly excavated by ulceration. 5219

77. The left radius of a young subject, the upper part of the shaft of which has been fractured by a bullet; the detached fragments are covered with new bone. Portions of the ends of the main fragments have suffered necrosis. 5218

The limb was amputated about a month after the injury.

78. Parts of a left radius and ulna, together with the lower half of the humerus: the former bones have been transversely fractured about 6 cm. below the



elbow-joint. No union has occurred between the fragments of the ulna, but those of the radius are held together on their outer side by a bridge of new bone; the adjoining ends of the bones are enlarged and rarefied from inflammation, the increase in size being due chiefly to the formation of new bone upon them. 1855

Amputation was performed some time after the injury. From the battle of Ostrolenka, Poland.

79. The upper end of a left femur, extensively comminuted as the result of a gunshot injury. The fracture extends into the head of the femur. New bone has been deposited on the fragments and the adjoining part of the shaft. 5213

The bullet, entering the gluteal region, perforated the sciatic nerve, and passed completely through the neck of the femur; it was found, very little altered in shape, lying immediately below the great trochanter. From the direction of the track, it is probable that the injury was received whilst the hip-joint was flexed in running.

80. A left femur, fractured near the middle of its shaft by a round bullet. Posteriorly a fissure 9 cm. in length leads from the seat of fracture towards the knee-joint. Considerable portions of the ends of the fragments have undergone necrosis, and their separation is far advanced, the edges of the necrosed portions being completely undermined. New bone has been formed in irregular masses on the shaft, but no union of the fragments has been effected. 1408

81. The lower end of a left femur, the shaft of which has been injured by a round bullet. A considerable piece of its wall about 5 cm. above the outer condyle, with part of the cancellous tissue, has been detached. From the circular portion of the aperture in the bone a fissure extends for 5 cm. upwards in the anterior wall of the shaft, and a second for a shorter distance downwards towards the knee-joint. The surface of the shaft around is irregularly covered with a thin layer of new bone. The cancellous tissue beneath the articular surface has been uniformly exposed by ulceration, showing that the subcrureal extension of the synovial membrane of the knee-joint was injured, and that suppuration occurred in the knee-joint. 3175

82. The lower end of a left femur, fractured by a conical bullet, which entered the thigh immediately above the inner condyle and passed backwards and outwards, carrying with it a large number of small fragments so as to hollow out the lower part of the bone. From the track of the bullet through the bone fissures pass in various directions, completely separating the condyles from the shaft and from each other. 5209

The limb was amputated about three weeks after the receipt of the injury; the patient died of pyæmia.

83. The upper end of a right tibia, the head of which has been perforated by a bullet, which entered posteriorly below the inner tuberosity, and emerged from its upper surface on the outer side of the middle line, making its exit through the knee-joint. The head itself is split into several fragments. A thin layer of new bone has been deposited around the seat of injury, and the edges of some of the fragments have undergone necrosis. 5210

84. The femur of a pony, in which an extensive comminuted fracture of the shaft has been produced by a Lee-Metford bullet fired at point blank. The cupronickel envelope of the bullet is much distorted, and the core of lead and antimony to a large extent discharged. 7268

85. The tibia of a pony, in which a very extensively comminuted fracture has been produced in a manner similar to the preceding. The bullet is bent and its apex depressed. 7267

86. A right foot, showing the apertures of entry and exit resulting from the passage

of a round bullet transversely through it. The aperture of entry, situated upon the outer aspect, has an almost circular outline, and measures about 2 cm. in diameter; its edge is slightly inverted and irregular from laceration.

An irregular aperture on the inner aspect, about 3 cm. in diameter, and around which the soft parts are protruded, marks the seat of exit. The skin here has been ruptured in a radiating manner; the rents in it, which extend 10 cm. along the foot and 6 cm. across it, are widely gaping, and about the aperture itself portions of the integument are almost completely detached. A fragment of one of the tarsal bones, encrusted with cartilage, lies within the end of the track. The section through the ankle-joint shows that the astragalus also has been fractured.

3740

- 
87. Fragments of the bones of a Malay, who was killed and devoured by tigers. From the femur both the articular ends have been gnawed away. The lines of the fractures are irregularly transverse and jagged; indentations and furrows made by the teeth exist upon the adjoining surfaces of the shaft; on the remains of the clavicle, scapula, and ulna similar marks are discernible.

3724

#### INJURIES OF SPECIAL BONES.—SKULL.

##### CEPHALHÆMATOMA.

As the result of pressure during birth, often instrumental, or occasionally from a blow on the head in a young child, extravasation of blood above or beneath the periosteum may occur, giving rise to the condition known as cephalhæmatoma. In the most important variety the extravasation is subperiosteal (88); the swelling is then limited to one bone, never passing a suture, and is almost exclusively seen on the parietal bone. The swelling is soft in the centre and surrounded by an elevated hard ring; in the angle formed by the raised periosteum and the bone new osseous tissue is often formed, and in very rare instances this may extend as a thin layer over a considerable part of the swelling. Other examples of cephalhæmatoma are preserved in the Obstetric Series.

88. The right parietal bone of an infant, beneath the periosteum of which an extravasation of blood has occurred. The periosteum has been separated from the upper half of the bone, the separation above and at either end being limited by the margin of the bone. The space appears to have been tensely filled with blood. The upper border of the swelling is abruptly rounded; the lower border shelves gradually to the natural level of the parts and is sinuous.

3876

#### CONTUSIONS OF THE VAULT OF THE SKULL.

A severe contusion of the bones of the vault of the skull, especially when accompanied by an open wound and separation of the periosteum, frequently gives rise to more or less extensive necrosis. This condition derives its importance from the fact that, when the whole thickness of the outer table is necrosed, suppuration may occur in

the diploë. This is often followed by plugging of the veins of the diploë, softening of the clots, and pyæmia. When both tables are necrosed pus may accumulate between the dura mater and bone, and cause fatal compression of the brain (89). If the necrosed fragment separates, the aperture so left is closed by a dense membranous cicatrix, little or no bone being formed (90).

89. The roof of a skull in which an elongated portion of the outer table, about 9 cm. long, involving the anterior and middle parts of the right parietal bone, together with the adjoining portion of the frontal, has undergone necrosis, as the result of a septic wound involving the bone. The necrosed part, in the centre of which the mark of the injury is still evident, is in process of separation, being completely surrounded by a deep groove, outside which a narrow ridge of somewhat dense new bone has been formed. Internally the extent of the necrosis is considerably less, and is indicated in part by a commencing groove of demarcation, but chiefly by the abrupt termination of a layer of new osseous tissue which has been deposited upon the living bone around; the surface of the necrosed part is irregularly pitted by ulceration. Over the frontal eminence of the same side is a small, depressed, and ulcerated surface, from which a sequestrum has exfoliated. 114

The patient was an epileptic, who in a fit fell against the bars of a grate and burned the integuments of his head. Exposure of the bruised bone subsequently resulted.

Death was probably due to intracranial suppuration.

90. The roof of a skull in which a portion of the outer table as large as a five-shilling piece situated in the middle line, about midway between the ends of the sagittal suture, became necrosed after a scalp wound and has exfoliated. The surface resulting from the separation of the sequestrum is irregularly pitted, and on the left side of the middle line presents a small oval perforation. The outer surface of the bone behind the area of necrosis is raised and eburnated. 5307

The patient, æt. 47, was thrown out of a swing, and struck her head on a paving-stone; profuse bleeding ensued, and when she was brought to the hospital bare bone was felt at the bottom of the wound on the vertex.

On the fifth day after the accident a rigor occurred, and after this till death there were frequent rigors. The temperature after the first rigor never fell to the normal, but varied from 101° to 105°. Death occurred eleven weeks after the accident. No pyæmic abscesses were found, the viscera were healthy, and there was no evidence whatever of any intracranial lesion; a thin stratum of pus lay beneath the sequestrum.

The diploë was somewhat injected, but there was no evidence of there being pus in the veins.

91. The roof of a skull in which extensive loss of substance has occurred in the left parietal bone, probably as the result of necrosis after injury, the limits of the necrosis above and behind coinciding with the sagittal and lambdoid sutures respectively. In those parts in which the loss of substance has involved the whole thickness of the skull the defect is closed by the adherent dura mater, which appears to have been healthy. The edges of the defect are smooth and shelving, and new osseous tissue, which has become as dense as the normal compact bone, has been thrown out on the neighbouring parts of the left parietal bone.

92. Portion of the roof of a skull, with the soft parts covering it. An irregular portion of the skull, including its entire thickness, has been removed by necrosis, the integument being destroyed for a corresponding extent. Externally a deep scar marks the seat of the defect. The edge of the skin around has been tightly drawn towards the centre of this by the contraction consequent upon the healing of the wound, to such an extent as to cover the margin of the aperture in the bone; the cicatricial tissue is inseparably combined with the subjacent dura mater. 3354



The patient was a boy, 11 years of age, who had received a blow on the head. A puffy swelling formed and was incised, after which the patient became subject to fits, which were relieved by the evacuation of pus from the wound. Exfoliation of the cranium, accompanied by a collection of pus between the dura mater and the bone, ensued; a portion of the bone was removed by the trephine and cutting pliers, after which the dura mater became rapidly united to the integument of the head. Some time afterwards the patient complained of pain in the back of the neck, and an abscess pointed below the right scapula, and was opened; paralysis of the right upper and of both lower extremities suddenly supervened, and the patient died. After death the cervical portion of the spinal cord was found much softened, and its substance infiltrated with purulent fluid.

### FRACTURES OF THE SKULL AND THEIR COMPLICATIONS.

The following are the varieties of fracture of the skull, which are illustrated in the specimens, and the chief points to be observed:—

1. *Fissured Fractures* (93, 94).—Fissured fractures always start from the point at which the violence was directly applied. The point struck can usually be recognized by two or three fissures radiating from it (93). There is no specimen in the Museum of the so-called fracture by *contrecoup*, and it is doubtful if such a condition exists.

Fissured fractures may be limited entirely to the vault of the skull (93); but frequently they extend into the base (127). To reach the base the fissure often leaves the bone and runs for a short distance along a suture, after which it re-enters the bones (131). In the base fissures may extend into the anterior (134), the middle (129, 137), or the posterior fossa (133, 134). In the anterior fossa they may implicate the cribriform plate or olivary eminence, and so open the cavity of the nose or pharynx (132, 134), or they may extend through the roof of the orbit (132). In the middle fossa they often cross the petrous portion of the temporal bone, generally opening into the cavity of the tympanum (137).

Fracture of the base may also arise from the impact of the spine upon the condyles of the occipital bone (132).

2. *Fractures with Depression* (102, 104).—In these sometimes the outer table is partly fractured and partly bent (102, 131); sometimes the depressed fragment is completely loose. Many of these specimens show the results of operations undertaken for relief of the depression (116).

3. *Punctured and Incised Fractures*.—The chief point to be noticed in these is that the inner table is much more extensively splintered than the outer (126, 128). If the bone be perforated from within, as by a bullet completely traversing the skull (61, 62), it will be observed that the outer table is more extensively comminuted than the inner.

Amongst the most important complications of fractures of the skull are:—

1. *Intracranial Hæmorrhage*, with or without laceration of the cerebral substance. Extensive extravasation between the bone and dura mater may result from rupture of a large branch of a meningeal artery (98, 135), and serious hæmorrhage may result from wound of one of the large venous sinuses (107). Extravasation may also occur into the subdural or subarachnoid space or into the substance of the brain.

2. *Intracranial Suppuration*.—This may be subcranial, meningeal, or cerebral. Localized suppuration is most frequently subcranial or cerebral, and is particularly likely to complicate punctured fractures (126) and gunshot fractures (63). Septic phlebitis of the sinuses, occasionally followed by pyæmia, may also occur (107).

3. *Hernia Cerebri*.—In fractures with loss of bone and wound of the dura mater the brain-substance may protrude as the result of increased intracranial pressure. When, as is usually the case, this condition is complicated with sepsis, the protruding mass consists of brain-substance mixed with inflammatory products (117).

## FISSURED FRACTURES OF THE VAULT.

93. The vault of the skull of a young person, showing a recent fissured fracture, extending antero-posteriorly through its whole length. In the position where the fracture passes through the parietal eminence two fissures, confined to the outer table of the bone, radiate from the main fracture, one passing upwards and backwards, and the other downwards and backwards.

The radiation of the fissures from the right parietal eminence indicates this as being the point struck.

94. The roof of a skull, in which a fissure extending from the right parietal eminence to the margin of the opposite temporal fossa has completely healed, a depressed line alone remaining to mark its situation.

Leading from the same spot there are two other fissures which have occurred at some time subsequently; one of these passes almost horizontally through the parietal bone, the other downwards through the posterior part of the temporal fossa and in a line exactly continuous with that which has healed. No sign of repair exists in these last, their edges being everywhere sharp and presenting all the appearances of a recent fracture. 3242

There is no history to the specimen.

95. The upper part of a skull, in which a fracture, running obliquely downwards and forwards, has at some time occurred about the left parietal eminence. The fissure is united at a series of points by new osseous tissue, which has a smooth compact surface like that of the bone around. Upon the inner surface also the upper end of the fissure is bridged across by new bone, resembling in texture the rest of the internal table. 3248

96. The left half of a skull, showing repair after fracture. Four fissures radiate from the parietal eminence; three of them have become almost imperceptible, but in the fourth, which extends to the root of the zygoma, absorption of the edges of the fissure has occurred, leading in parts to complete perforation, and in the remainder of its extent to a deep groove. The inner table, except in the position of the perforations, shows no traces of the injury. 2650

97. The roof of a skull which is traversed through the whole of its length by a fissured fracture running almost exactly in the middle line. 6807

The patient, a man æt. 46, fell from a height of 15 feet on to the back of the head, and was at once brought to U. C. H. He was barely conscious, and there was an extensive extravasation of blood under the scalp over the superior and lateral aspects of the head. The eyes deviated to the right; right pupil semi-dilated, left contracted, both fixed; breathing irregular; pulse 56. Complete coma soon supervened and slight rigidity of the limbs. Death occurred in 15 hours. P.M. report:—Extravasation of blood between epicranial aponeurosis and pericranium; fracture as shown in the specimen, extending from the occipital protuberance to the glabella; longitudinal sinus torn at middle; laceration of tips of frontal and temporal lobes and bruising of occipital lobe; widespread effusion of blood on surface of cerebral hemispheres and cerebellum; small hemorrhages in floor of 4th ventricle and in substance of pons and crura. (*Case-book*, Sundry, 1891, p. 498.)

98. Part of the left side of a skull, with the dura mater reflected, showing a fissured fracture passing from above through the anterior part of the parietal bone, and beyond its anterior inferior angle along the great wing of the sphenoid in front of the root of the pterygoid process and across the body of the sphenoid. In the great wing of the sphenoid, slightly above the level of, and about 4 cm. behind, the external angular process of the frontal bone, the fracture is comminuted;



and from this situation a fissure leads for a short distance backwards, and afterwards downwards, in the squamous portion of the temporal bone. Opposite the seat of comminution the anterior division of the middle meningeal artery was lacerated; pieces of bristle have been placed in the torn ends of the vessel.

A circle of bone has been removed by the trephine 5 cm. behind the external angular process of the frontal bone, and 6 cm. above the root of the zygoma. The aperture is confined to the anterior and lower part of the parietal bone: its relation to the dura mater is marked by bits of bristle arranged in a circle in the latter. The lower edge of the aperture is higher by about 2 cm. than the ruptured portion of the artery.

The patient was admitted into U. C. H., under the care of Mr. Beck, in Jan. 1877. He was a carman, and fell from the seat of his van on to the pavement. He was able to get up, and drove again for a short way, but soon complained of feeling giddy, and lay down in the van. The man who was with him, being intoxicated, drove him about for an hour and a half before bringing him to the hospital. He was then found to be profoundly comatose. On shaving the head a bruise was found in the left parietal region, and the left temporal fossa was distinctly fuller than the right. An incision was therefore made with the intention of trephining in the line of the middle meningeal artery. A fissured fracture was found and a disk of bone removed where the line of the artery was crossed by the fracture. A clot was exposed of such a size that the finger passed directly inwards for about 5 cm. before the dura mater could be felt. On removing the clot no bleeding-point could be seen, but blood poured in large quantities from the interior of the skull. The bleeding ceased spontaneously in a short time; but the brain, although it pulsated, never showed any sign of expanding, and the patient died, as comatose as he was before the operation, in about eight hours. No cause was found after death for the want of expansion of the brain.

99. The two portions of the parietal bone which were removed by trephining from the preceding case. They are of nearly equal size, the pin of the trephine having been applied close to the line of fracture.

100. A large coagulum, shaped like a placenta, and about 9 cm. in diameter, together with the portion of the dura mater upon which it rests. The outer surface of the coagulum is very uneven. The dura mater appears healthy; but adhering to its inner surface are portions of a thin rust-coloured film, probably a layer of blood effused into the space beneath it. 2393

The clot has almost certainly resulted from hæmorrhage from one of the meningeal arteries wounded in a fracture of the skull, the blood accumulating between the dura mater and the bone producing compression of the brain.

101. Five disks of bone removed *post mortem* by the trephine to illustrate the operation of trephining for rupture of the middle meningeal artery. In A, B, C, and E the pin of the trephine was applied at a point 5 cm. behind the external angular process and 5 cm. above the zygoma, and in each the groove of the anterior branch of the artery is seen on the bone. In D the trephine was applied 3.5 cm. behind the angular process, and the same distance above the zygoma, and in its whole course across the disk of bone the artery lies in a canal. The varying thickness of the skull in this region is well shown in the specimen. 5440

#### FRACTURES WITH DEPRESSION.

102. The upper part of a skull in which an elongated area near the middle of the left parietal bone, measuring 3 cm. and 6 cm. in its chief diameters, has been recently depressed after comminution. The depressed part projects inwards with a sharp edge against the dura mater: along its middle the outer table is bent without being actually fractured. 3238



103. Part of a calvaria showing a recent depressed fracture near the anterior extremity of the sagittal suture. A small quadrilateral area of the outer table, measuring 1 cm. across, is detached from the surrounding bone except posteriorly, and very slightly depressed. The depressed fragment of the inner table, which is much more extensive, measures 2.5 cm. from before back, is fissured transversely across its middle, and is continuous in front with the surrounding bone.

104. Part of a right parietal bone in which a depressed fracture involving a circular area, measuring 4.5 cm. in diameter, has been completely repaired. In its lower part the depressed fragment has been bent in without being actually fractured. A transverse groove externally and a corresponding ridge internally indicate the position of a fissure in the depressed bone.

From a man *æt.* 70, who met with the injury from the blow of a quoit forty years before death. He died from a fracture of the base of the skull.

105. The anterior part of a calvaria showing repair after a depressed fracture of the upper part of the frontal bone. In the outer table the depression is oval and measures 2.5 cm. from before back, and 2 cm. transversely. The borders are shelving except posteriorly, where it is limited by a vertical edge 6 mm. in depth, beneath which the bone presents a linear perforation. The depression of the inner table is much more extensive in area, and extends 12 mm. beyond the middle line. 7913

106. A triangular fragment, 3 cm. by 2 cm., from a compound depressed fracture of the frontal bone. Two of the borders are bevelled at the expense of the outer table, and a piece of whalebone has been passed through the canal of a diploic vein which traverses the bone. 7538

From a boy *æt.* 12 admitted under Mr. Beck, July 20, 1881. There was a lacerated wound above the right eyebrow, which had been produced by the kick of a horse. The bone was depressed, and brain-matter protruded between the fragments. The fragment preserved in the specimen and several smaller ones, which were depressed to the extent of 12 mm., were elevated and removed. In raising the larger fragment free hæmorrhage occurred from a torn diploic vein, and was arrested by applying a ligature to the vessel which had been pulled from its bed. The patient recovered.

107. Part of the left side of a skull, in which an extensive compound fracture of the parietal and squamous portions of the temporal bones has occurred, with depression of the detached fragments; the fracture extends also, for a short distance, into the frontal bone. One of the depressed fragments was driven backwards and downwards so as to wound the lateral sinus. A large portion of the lower part of the parietal bone, together with part of the adjoining portion of the temporal, was removed during life. The aperture in the bone, resulting from the removal of the detached fragments, is about 7 cm. long, and posteriorly about 3 cm. in breadth; from its lower posterior margin a fissure leads for a distance of about 4 cm. downwards and forwards through the squamous division of the temporal bone; and there is a second fissure anteriorly by which (in the present condition of the parts) a long strip of the parietal and frontal bones is isolated from the rest.

A semicircular portion of the parietal bone round the posterior margin of the aperture is necrosed and surrounded by a shallow ulcerated groove. The dura mater, in this situation, is separated from the bone, and its outer surface is shreddy, as if ulcerating; in one spot it is perforated; the inner surface of the dura mater is dull ashy grey, and in parts covered with inflammatory exudation. Suppuration occurred between the dura mater and the skull and in the opened sinus. A piece of blue glass has been passed from the exterior along the separated dura mater into the wounded sinns, and from the latter a bristle has been passed through the mastoid foramen; the periosteum is separated for a short distance from the bone round the foramen. The sinus itself contains a softening coagulum, and its interior is wanting in lustre.

The patient, a man about 35 years of age, was admitted into U. C. H. in 1876.

While sitting on the buffer of a railway truck he was struck on the head by a piece of bar-iron projecting from the next truck, which was driven back by the engine. On admission he was partly conscious; he had lost much blood, but at the time of admission bleeding had ceased. There was a lacerated wound above and behind the left ear, and depressed bone was felt in this. The depressed fragment could be felt to be driven downwards and slightly backwards, so as to lie completely overlapped by the sound bone. An elevator was put under it and it was gently raised. Immediately a torrent of dark venous blood poured from the wound. The fragment was removed as quickly as possible, and the wound plugged with lint. In order to arrest the bleeding it was necessary to tuck the lint beneath the sound bone, and (as the specimen shows) actually into the lateral sinus. On the third day convulsions set in, commencing on the right side of the face, then, in order, affecting the right arm, right leg, left leg, left arm, and left side of the face. These were repeated over a hundred times; they ceased about the tenth day. The plugs were removed on the fifth day, but the bleeding immediately recommenced. They were again introduced, and finally were removed on the fifteenth day. Rigors commenced before the end of the first week and were frequently repeated, till the patient died on the thirtieth day after admission. Before death he had almost completely regained consciousness and intelligence. During the last week of life a large abscess formed in the back of the neck under the splenius muscle; on squeezing this, pus could be made to well up between the dura mater and the bone.

The specimen shows that this abscess was due to thrombosis, with secondary breaking down of the clot and suppuration around the mastoid vein.

At the *post-mortem* examination the lateral sinus was found to be filled with softened clot.

The lungs contained numerous secondary abscesses; all the other organs were healthy.

108. The portions of bone removed from the preceding case.

109. A cast of the top of the head of a child six weeks old, showing an almost circular depression, about 3.5 cm. in diameter, in the frontal region on the left side.

No symptoms of compression at any time existed; and the child was living eight months afterwards with the depression still remaining.

110. Plaster cast of the top of the head of a man who was trephined when sixteen years old, on account of a depressed fracture of the skull. The portions of bone removed included the upper parts of both parietal bones and the central superior portion of the frontal bone.

The depression was caused by the falling of a block from the rigging of H.M.S. 'Mermaid.'

"He is now (September 1844) 67 years of age and in the enjoyment of all his faculties."

The patient was in Haslar Hospital, under Mr. Dodd, in 1793.

111. The roof of a skull, in which a depressed fracture has occurred towards the anterior and upper part of the left parietal bone; the dura mater was also injured. The trephine has been applied in front of the seat of fracture, and has included the adjacent part of the coronal suture; a V-shaped piece of the parietal bone has, in addition, been removed posteriorly with a Hey's saw. At the site of fracture the inner table is wanting for the breadth of 3 cm., the loss here considerably exceeding that in the outer. No bone remains depressed. 4970

112. Parts of the occipital and left parietal bones; the former has been trephined behind the seat of a depressed fracture, about 2.5 cm. above the lateral sinus, and partly over the lambdoid suture. The outer table of the parietal bone in front of the aperture made by the trephine presents two concentric semicircular fissures, 1 cm. apart, the upper about 4 cm. in length, the lower about 1.5 cm. The depression of the outer table is scarcely perceptible; but the inner table, over an area included by the external injury, is considerably depressed, and a fissure extends through it as far forwards as the end of the bone remaining.

The depressed portion consists of two fragments not completely separated, the bone at their attached borders being bent without being fractured; the sharp edges of the fragments project inwards about 4 mm. Behind the lower part



of the lambdoid suture, and parallel with it, the occipital bone also has been fissured. 3149

113. The roof of a skull, in which there is a long fracture passing from the neighbourhood of the right parietal eminence across the sagittal suture, and the posterior superior angle of the left parietal, into the occipital bone. At the first-named situation the depressed fragments were removed by the application of a trephine and saw; beyond this situation two strips of bone, one of which is wanting, have been entirely separated. 101

114. The roof of a skull, in the left parietal bone of which, about midway between its upper angles and extending across the sagittal suture, is a triangular hole measuring about 4 cm. along its sides. The mesial corner of this has been enlarged by the trephine, which has been applied over the course of the longitudinal sinus. Except in the situation last named, the edge of the opening is bevelled from within, and immediately beyond the anterior angle of the aperture the external table presents two short converging fissures. 1081

115. Five elongated, angular, scale-like pieces of bone which were removed during life from the preceding case. Some consist of the inner table and diploë, the others of the outer table with portions of the subjacent diploë. 1081

116. A frontal bone broken into several fragments by the kick of a horse. In its centre there is an aperture, 2.5 cm. and 7 cm. in its chief measurements, due to removal of some of the fragments; on the left side an additional part has been removed by trephining. From the aperture fissures extend in horizontal and transverse directions so as to divide the bone remaining into eight separate pieces; some of the fractures extend into the orbital plates. 4102

The patient was rendered insensible for a few minutes by the blow. Some of the brain escaped from the wound; the pupils were contracted. Convulsions came on and recurred at intervals for some days. About a fortnight afterwards rigors followed, and in three or four days the patient died. The anterior lobes of the brain were found after death softened and mixed with blood.

117. The left half of the roof of a skull, with a portion of the left hemisphere of the brain. In the posterior and lower part of the frontal bone, and extending into the adjoining portion of the parietal, is an irregularly oval aperture about 6 cm. in length, resulting from the removal of the portions of bone depressed in a comminuted fracture, and of an additional part in front, which was removed by trephining, to allow of the extraction of the depressed pieces; the edges of the opening are sharp and jagged. Through the aperture a portion of the brain has protruded (*hernia cerebri*), the projecting part having a very uneven, lobulated, and roughened surface, as though portions of its substance had been removed after sloughing; and in many situations it is deeply blood-stained from interstitial hæmorrhage. The protruding part accurately occupies the opening in the bones, and the substance of the brain for a considerable distance beneath appears to have been softened. It is observable that the loss of substance within is not commensurate with the external protrusion, the protruding mass being composed partly of cerebral substance and partly of inflammatory products.

118. The portions of bone removed in the preceding case. Some of the fragments of the inner table are missing.

The patient was a man, 24 years of age, who, whilst running, fell against an iron spike. He was brought to the hospital not quite insensible, Feb. 23, 1875. There was a small lacerated wound of the scalp, through which the finger could be passed; underneath the scalp the skull was fractured and depressed, and a small portion of brain-substance was protruding through the fractured parietal bone; this was detached and removed by the finger. There was considerable loss of blood. Pulse small and about 96; pupils equal, acting readily to light, and of normal size. The wound was situated somewhat above and anterior to the left parietal eminence.



Mr. Marshall, after trephining, removed the depressed portions of bone. The inner table of the skull was much more comminuted, and the fractures extended over a larger area than corresponded with the fractures of the outer table. There was then found a rupture of the meninges, about  $1\frac{1}{4}$  inch in length. The brain was seen through this aperture pulsating, and rising and falling in the usual way. There was considerable arterial haemorrhage, the blood welling up from within the dura mater at each movement of the brain. The wound was dressed with a piece of lint soaked in weak carbolic-acid lotion, and over this a larger piece of lint soaked in carbolic oil, both being placed underneath the edges of the wounded bone.

About half an hour after the operation the pulse was 100, respiration 20, temperature in axilla  $96^{\circ}\cdot4$ , and the patient was perfectly sensible; there was no paralysis nor loss of sensibility. In the evening of the following day (Feb. 24) the temperature was  $105^{\circ}\cdot2$ , pulse 105, respirations 21.

On Feb. 25 a slight protrusion of whitish brain-substance was observed from the wound in the dura mater. Temp.  $103^{\circ}\cdot4$ .

Feb. 26. Temp.  $108^{\circ}$ ; the patient had two rigors. The hernia cerebri was more than double the size it was on the preceding day, and was still of a whitish colour. On the same day the patient became quite unconscious, and in the afternoon died. There was no rise of the temperature after death.

*Post-mortem Examination.*—The hernia cerebri had shrunk to about half the size it had before death, and now formed a reddish-yellow mass measuring about  $2\frac{1}{2}$  by 2 inches. On removing the skull-cap the dura mater was found to be extremely adherent to the bone, but presented no abnormal appearance either inside or outside; a thin edge of purulent lymph surrounded the part exposed in the wound, and effectually prevented the extension of fluid between the dura mater and the bone.

There was purulent lymph on the arachnoid over the upper and anterior part of the left hemisphere. The vessels of the pia mater were injected over the whole surface of the brain.

The brain itself showed a remarkable absence of red points, and was notably paler than natural. The heart was full of blood, and the other organs congested.

(For further details see Mr. Marshall's *Case-book*, 1875, p. 173.)

119. The upper part of a skull, of which the anterior part of the left parietal bone was fractured over a large area, in consequence of a fall.

Several fissures extend from the point struck; one of these passes directly downwards, about 1 cm. behind the coronal suture; another, following at first the line of the coronal suture (which is opened up as far as the temporal line), leads through the anterior and lower angle of the right parietal bone. The anterior third of the skull-cap is thus separated from that behind.

A portion of the frontal bone in front of the injury has been removed with a trephine, and a triangular fragment immediately behind divided across with a Hey's saw. The injury of the skull accurately corresponds on both aspects. 102

The patient was a sailor, who fell upon his head into the hold of a ship. Six days afterwards symptoms of compression appeared. An incision was made over the seat of injury and the skull trephined, the three portions of bone now loose being removed. No improvement in the symptoms followed. After death nothing remarkable was seen beneath the fracture. On the opposite side of the head, over the petrous portion of the temporal bone, about an ounce of coagulated blood was found between the dura mater and the brain; and on this side also, about the centre of the parietal bone, was a circular patch about 5 cm. in diameter covered with pus, and another of the same kind opposite the junction of the sagittal and lambdoid sutures. A fracture extended across the base of the skull.

120. Two portions of bone removed from a skull by trephining, together with numerous irregular fragments of the cranium and a stone which was impacted amongst them. 2895

The patient, a man 35 years of age, fractured his skull by falling upon the sharp corner of a stone. On the morning following the accident the portion of stone preserved was extracted, after which the patient suffered little inconvenience, but towards evening complained of giddiness. The trephine was applied, and the portions of detached bone were removed. He died some days afterwards from inflammation of the brain.

121. Two circular portions of a skull removed by trephining, together with several smaller pieces of different sizes, some consisting only of scales of the internal table. 2967

The patient, a man aged 34, sustained a punctured fracture of the skull in consequence of a blow from a small stone, which fell from a great height. The patient recovered.

122. Portion of the roof of the skull of a girl 11 years old, in which are two circular apertures made with a trephine and continuous with each other; the one on the right is situated over the longitudinal sinus. The outer surface of the dura mater thus exposed is covered with a thin layer of inflammatory exudation, which also surrounds the edge of the aperture in the bones and closes the cancellous tissue of the diploë. The inner surface of the dura mater is unaltered in appearance. 420

The injury was caused by a brick falling upon the head. On admission to the hospital the patient was trephined; the wound was afterwards dressed with lint dipped in oil. There were no unfavourable symptoms till the eighteenth day, when rigors and sickness occurred; death followed on the twenty-ninth. During the last two days the patient was comatose. After death serum was found under the membranes of the brain and within the ventricles. The veins of the pia mater near the seat of the injury, and the longitudinal sinus, were plugged with pale softening coagulum. The brain, in general appearance, was blanched, and there was very little vascularity in the neighbourhood of the injured part.

#### INCISED AND PUNCTURED FRACTURES.

123. Part of a frontal bone, in which there is a fracture extending from between the superciliary ridges to within a short distance of the coronal suture, caused apparently by a blow from some edged weapon. Portions of the bone are depressed and firmly united in their altered situation; by the removal of others an irregular slit-like aperture remains. At the highest part of the fracture the inner table is depressed for about 5 mm.; the area of depression within the skull is of considerably greater extent than would appear from the fracture as seen externally. The edges both of the fractured bone and of the depressed portions are smoothly rounded on both aspects, and their diploë is everywhere closed by a layer of compact bone. A rough spiculum of new bone projects from the inner surface of the bone depressed at the upper end of the opening. 3155

124. A piece of the roof of a skull, in which a punctured fracture was made experimentally after death. Viewed externally, the fracture appears as a deep depression 1.25 cm. in length by 2 mm. in breadth; at one end of the depression the skull is completely perforated. A larger portion of the inner table has been depressed and completely detached, except at one border where the bone is bent without being actually fractured. 5441

125. The roof of a skull, showing repair of a punctured fracture below the right parietal eminence. Externally the fracture appears as a smooth depression, at the deepest point of which is a minute perforation. Internally a conical eminence, from the summit of which project three or four bony points, almost exactly corresponds to the external depression. 3260

126. A disk of bone in which is a punctured fracture removed by trephining. In its centre is the mark of the pin of the trephine, and close to this an almost square hole measuring about 3 mm. across; the aperture in the inner table is almost double the size and of less regular form. 2436

The portion was excised from a boy by Mr. Cooper three weeks after the accident. When admitted to the Hospital a few drops of pus, which had formed between the dura mater and the bone, oozed through the aperture. The patient recovered.

127. The left half of a skull in the parietal region of which a punctured fracture has been treated by trephining. The trephine has been applied so as to include the posterior part of the fracture in the outer table; the anterior part of the fracture appears as a square hole 6 mm. across. The depression of the inner table involves an area measuring 2.5 cm. across. None of the depressed fragments remain. 3247



128. A disk of bone removed by trephining for a punctured fracture. Immediately below the mark of the pin of the trephine the fracture in the outer table appears as a transverse elliptical opening, measuring 12 mm. by 6 mm. The outer table is depressed about 3 mm., and between it and the lower edge of the undepressed bone there is a small perforation. The damage to the internal table is more extensive, involving an area measuring 2 cm. by 12 mm., the bone being incompletely separated into several fragments and depressed at its central part for nearly 6 mm. The whole of the depressed area is included within the trephine ring. Above the bone is seen the piece of stone by which the injury was produced. 8051

T. R. H., a boy, æt. 7, fell from a wall 8 feet high on April 8, 1898. The stone, which was impacted in the bone 5 cm. above the right orbit, was pulled out five minutes later. A medical man was called in and stitched up the wound. An hour later convulsions occurred, beginning in the left arm and spreading to the rest of the left side of the body. On admission the boy was very drowsy, and there appeared to be slight paresis of the left side. There was a punctured wound above the right orbit, in which the fracture could be felt with a probe. Operation by Mr. Johnson:—A semilunar flap of the scalp, having the wound at its centre, was turned downwards and a disk of bone including the fracture removed with the trephine. The wound in the dura mater was enlarged and a small puncture seen on the surface of the brain. The parts were thoroughly cleaned with 1 in 500 mercurial lotion, and the edges of the puncture in the scalp excised. The wound was sutured and dressed with cyanide gauze. Discharged well on April 27. (Mr. Barker's *Case-book*, 1898, Reg. No. 643.)

#### FRACTURES OF, OR EXTENDING INTO, THE BASE OF THE SKULL.

129. The skull of a young person in which a fracture passing into the base of the skull on the left side was caused by a fall on the head. A portion of the frontal bone to the left of the middle line is slightly depressed. On the right side the coronal suture is opened for about 5 cm., and the fracture is continued as a fissure leading backwards to the parietal eminence (the continuation of the fracture beyond this point has been produced accidentally). The main fracture crosses the anterior and lower part of the left parietal bone, and at the margin of the squamous portion of the temporal divides into two branches, of which one passes backwards through the posterior inferior angle of the parietal bone, the other downwards and forwards across the squamous portion of the temporal, through the front of the meatus auditorius externus, and along the line of the Glaserian fissure into the foramen lacerum medium. The frontal bone is fissured more or less concentrically around the part struck. The separation of the basilar portion of the occipital bone from the body of the sphenoid has resulted from the destruction of their connecting cartilage by maceration. 2118
130. A child's cranium, in which there is a vertical fracture extending almost completely round it. Traced from the vertex the line of fracture passes, on the left side, to the centre of the parietal bone, where it bifurcates, the anterior smaller division passing downwards and forwards to the coronal suture, and the posterior irregularly downwards and backwards as far as the parieto-mastoid suture. On the right side the line of fracture takes an almost similar course; the parietal bone, however, is more extensively fractured in the neighbourhood of its eminence, showing this to have been the point struck; and the main fracture is continued onward through the opened occipito-mastoid suture, and across the occipital bone, behind its condylar part, into the foramen magnum. The separation of the basilar part of the occipital bone from the condylar portion behind and the sphenoid bone in front is the result of maceration. 3127
131. A cranium which has been fractured in an almost symmetrical manner by a fall on the head from a height. The anterior superior angle of the left parietal bone, probably the part struck, was depressed; the depressed fragment is



missing. On either side the fronto-parietal suture has been opened up to within 3 cm. of its end. From this point a fracture passes through the anterior inferior angle of each parietal bone across the situation of the middle meningeal artery, through the anterior part of the squamous division of the temporal on the left side and the great wing of the sphenoid on the right, and thence across the posterior part of the great wing of the sphenoid in front of the foramen ovale into the foramen lacerum medium. On each side also a fissure extends into the body of the sphenoid bone through the roof of the sphenoidal sinus. The depressed fragment of the parietal bone was somewhat wedge-shaped, its outer surface being considerably broader than its inner; in consequence of the impact of the skull against the ground the left parietal bone has been forced outwards, and projects in the lateral region for 5 mm. beyond the level of the frontal bone. To allow of this displacement three fissures pass in an irregularly horizontal direction backwards, one through the squamous portion of the temporal, the others through the parietal bone; the longer of the latter fissures runs in a zigzag manner for about 9 cm. through the upper part of the bone. 110

The patient fell from the window of a first floor. He died about half an hour afterwards. After death blood was found effused within the skull at both temples, and had escaped through the fracture beneath the scalp, where the effusion was more than 2.5 cm. deep.

132. The base of a skull, showing one fracture due to the impact of the atlas upon the condyles of the occipital bone, and part of a second fracture, which extended from the vertex to the base. The latter passes vertically through the anterior part of the squamous portion of the left temporal bone across the root of the zygoma and the glenoid fossa into the foramen lacerum medium; from the last-named situation it passes into the body of the sphenoid bone, and thence through the sphenoidal fissure into the left half of the frontal bone. The remaining part of the injury has been caused by the forcible impaction of the atlas, from the superincumbent weight of the trunk upon the condyles of the occipital bone, which in this situation is fractured in a radiating manner; the basilar part of the bone, thus separated from that behind, has been forced upwards, and the central part of the base of the skull in continuity with it broken across on each side, the fractures passing through the great wing of the sphenoid and across its body immediately behind the olivary eminence. On the right side the petrous portion of the temporal bone was broken off by the basilar process of the occipital bone having been driven upwards against it, and the semicircular canals and the Eustachian canal are extensively opened; the membrana tympani, however, was uninjured; and the fluid of the internal ear, together with the blood effused, must have escaped by the Eustachian tube into the pharynx.

The patient fell from a height of between 20 and 30 feet down a well-staircase, at the bottom of which he was found upright on his head between a ladder and the wall. He was at first stunned, but soon became semi-conscious and noisy. Almost immediately after reaching the hospital (about half an hour after the accident) he became again insensible and died in about twenty minutes. After death the brain was found only slightly lacerated; but there was a clot of blood in the medulla oblongata about the size of a pea. The fracture of the vertex, which extended to the base, started from the anterior and upper part of the right parietal bone.

133. The lower half of the back part of a skull. The condylar and basilar portions of the occipital bone have been completely detached by a fracture which probably resulted from the impaction of the vertebral column on the base of the skull in a fall on the top of the head. From the left margin of the foramen magnum a fissure runs backwards, and at a distance of about 2.5 cm. bifurcates, one branch running backwards in the occipital bone, the other upwards to the parieto-occipital suture. 106

Death occurred suddenly from a slight twist whilst the patient's head was being shaved, and was doubtless due to crushing of the medulla oblongata from displacement of the fragments.

134. The lower part of a skull, in which there is a fracture almost confined to its base, and occasioned probably by a fall on the back of the head. The part struck appears to have been the back of the occipital bone, from above the protuberance of which, and slightly to its right side, a fracture, radiate at its commencement, passes downwards and forwards by the side of the condyle into the jugular foramen. A fissure leads also across the base of the petrous portion of the temporal bone through the roof of the tympanum. On the left side the lower part of the occipito-mastoid suture is open, and the occipital bone itself is transversely fissured behind its condyle. The fracture reappears at the front of the basilar process, passing forwards and to the right side into the foramen lacerum medium, and afterwards directly forwards to the right of the middle line, through the body of the sphenoid bone and into the horizontal plate of the ethmoid.

135. Part of a right temporal bone which has been involved in a fracture of the skull, together with part of the great wing of the sphenoid. The line of fracture leads vertically through the squamous portion of the temporal bone, the external auditory meatus, across the cavity of the tympanum, and ultimately forwards along the Eustachian canal. Near the base of the petrous portion the fracture crosses the groove for the posterior division of the middle meningeal artery, which was ruptured.

3223

The patient fell on his head from a cart. After recovering sensibility he vomited and was giddy. Bleeding took place from the right ear, but he was able to walk. Two hours and a half after the accident he became comatose, pupils dilated, breathing laborious, and at the end of three hours he died. On opening the head a large clot was found between the bone and dura mater; the mastoid cells and tympanum were filled with blood: there was a small clot also beneath the dura mater covering the petrous portion of the left temporal bone.

136. A right temporal bone fractured horizontally through its mastoid and petrous portions. The line of fracture commences behind at the junction of the squamous and parieto-mastoid sutures, and is continued forwards through the roof of the external auditory meatus and tympanum into the Glaserian fissure.

7914

137. Part of the base of a skull which was separated into halves by a fracture extending completely across it. The line of fracture passes on either side vertically through the squamous portion of the temporal bone, along the external auditory meatus, across the attachment of the membrana tympani and roof of the tympanum, and thence along the Eustachian canal into the foramen lacerum medium, the separation being completed by a fracture extending transversely through the body of the sphenoid, close behind the posterior clinoid processes and posterior nares.

3116

138. Parts of a frontal and of both temporal bones, fractured six months before death. The inner ends of the petrous portions of the temporal bones have been separated across the line of the internal auditory meatus and internal to the situation of the tympanum: no sign of repair is discernible on the fractured surfaces. In the right orbital plate and adjoining part of the frontal bone is an irregular aperture, the edges of which are smoothly rounded and more porous than the bone around. The cribriform plate of the ethmoid is wanting; the crista galli, however, remains attached to the frontal bone.

4582

The patient was a boy 6 years old, who, slipping over a balustrade, fell to the bottom of three flights of stairs. He was admitted to the hospital with a compound comminuted fracture of the right supraorbital portion of the frontal bone; there were no signs of compression or paralysis present. He was discharged as cured about two months afterwards. The boy remained in good health for the four months following, when he was readmitted with signs of gastric irritation, which continued obstinate for a few days, and were succeeded by emaciation, irritability, indifference, coma, and about a month afterwards by convulsions, which rapidly proved fatal; no paralysis or rigidity existed at any time. At the post-mortem examination the brain was found reduced to a soft pulp on the right side; the ventricles contained about two and a half ounces of clear serum. The membranes of the base were



studded with tubercle and inflamed. The fracture, about which no recent change was observable, was united at its edges by a thin membrane, apparently the thickened dura mater, which was nowhere injured, although closely adherent to the bone.—Sir J. Erichsen's *Case-book*, March 1859.

## FRACTURES OF THE BONES OF THE FACE.

These result from direct violence, and involve most frequently the lower jaw or the nasal bones. The nasal bones are most commonly broken in their lower thin portions (139), the lower fragments being displaced backwards or laterally. When the result of severe violence, the fracture may involve the neighbouring bones, such as the nasal process of the superior maxillary (140). Fractures of the lower jaw are common. They occur most frequently through the body of the bone on one side of the symphysis (142); the line of the fracture is usually directed forwards and outwards, and the larger fragment is overlapped by the smaller, but the reverse may be the case (143). Fracture through the symphysis is very rare (145). Fractures also occur through the ramus, through the neck (146), or through the coronoid process. Fractures of the lower jaw are frequently multiple or comminuted (147). Union usually takes place by bone (143), but occasionally by fibrous tissue (146). Fibrous union is most likely to occur if loss of substance has been produced by necrosis (31); the comparative frequency of necrosis is explained by the fact that fractures of the body of the jaw are open into the mouth as the result of laceration of the gum.

139. A pair of nasal bones, showing a recent fracture involving their thin lower borders; a portion of the right is depressed and locked beneath the fractured edge of the bone. 2885

140. The bones and part of the cartilages of the nose, together with the adjacent bones, showing a recent comminuted fracture involving almost symmetrically the nasal bone and nasal process of the superior maxillary bone on each side. From its starting-point in the middle line at the lower end of the nasal suture the line of fracture passes downwards and backwards into the nasal notch. In the line of the fracture the septal cartilage is detached from the nasal bones. 5774

The injury resulted from a fall.

141. A plaster cast of the nose, showing the deformity resulting from a fracture of the left nasal bone. The bridge of the nose in its upper part is displaced to the left. 6882

From a girl, æt. 19, whose head was caught between a lift and the sill of the shaft. There was an external wound, and a ridge could be seen crossing the lower part of the left nasal bone; crepitus was felt.—Mr. Beck and Mr. Godlee's *Case-book*, 1892, vol. ii. p. 497.

142. A lower jaw fractured somewhat obliquely through the socket of the lateral incisor tooth of the left side. The condyle and adjoining portion of the ramus have, in addition, been separated by a fracture passing downwards and backwards from the sigmoid notch. 4206

143. A lower jaw which has been fractured, apparently with comminution and loss of substance, on the right side, and in which union has occurred after slight displacement of the main fragment towards the right so as to overlap the smaller fragment, which retains its normal position. In consequence of this displacement the outer edges of the teeth on the left side have been worn away by the inner edges of those in the upper jaw which were opposed to them.

144. A lower jaw fractured nearly vertically through the symphysis and the socket of the left mesial incisor tooth. The mesial portion of the alveolar process is wanting, and a portion, including the canine and first bicuspid sockets of the right side, is completely detached. 3708



145. A lower jaw, fractured vertically through the symphysis by a fall from a height; the soft parts of the chin were lacerated. Both the condyles have, in addition, been broken off almost symmetrically. 2634
146. The left half of a lower jaw, in which a vertical fracture through the body behind the second bicuspid tooth, and another through the neck of the condyle, have been united by fibrous tissue, the latter fracture after great displacement. The detached condyle is bent almost directly inwards, and the jaw is so displaced upwards that the condyle, when the parts are viewed in profile from the outer aspect, is almost concealed from view.
147. A lower jaw, broken into several fragments by a fall on the chin. One fracture passes vertically, close to the middle line, between the right incisors; and from between the bicuspid and molar teeth on either side another fracture extends obliquely downwards and forwards so as to separate the jaw into four main fragments. The two anterior molars on the right side, with the corresponding part of the alveolar border, are also separated from the rest; and twelve smaller pieces have been detached, chiefly from the posterior aspect of the jaw. 126
148. The lower jaw of an infant, fractured symmetrically on each side midway between the symphysis and the angle. On the left side the fragments are only loosely connected by fibrous tissue and a strip of the mucous membrane; in the cavity between them lay a small loose sequestrum. The first molar tooth is erupting immediately in front of the line of the fracture. On the right side the fragments are held in accurate apposition by fibrous tissue, allowing a limited amount of movement between them; on this side the first molar tooth is still deeply placed in the bone. 5522

From an infant one year of age, who fell from its bed three days before admission to U. C. H. The left cheek was much swollen, the breath fetid, and the gum lacerated over the fracture on the left side. The other fracture was not detected until the child was examined under chloroform twelve days later. Death resulted from broncho-pneumonia on the forty-fifth day. (Mr. Hill's *Case-book*, 1880, vol. ii. p. 433.)

#### FRACTURES AND FRACTURE-DISLOCATIONS OF THE SPINE.

Fractures of the vertebræ resulting from direct violence usually affect the spinous processes (151) or laminae (154). Complete fractures extending across the bodies and arches usually result from forcible flexion of the spine (155, 156). If the force lead to rupture of the ligaments there may be great displacement. In this case the upper part of the spine is almost invariably displaced forwards on the lower (152, 155, 157), although occasionally the reverse happens (159). The result of displacement is more or less seriously to injure the cord, sometimes merely bruising it (149), sometimes completely crushing it (156). The damage to the cord may be caused by the displacement of a fractured arch (149), but in a complete fracture-dislocation the cord is most commonly crushed between the laminae of the vertebra above the line of fracture and the body of the vertebra below (152). It not infrequently happens that the amount of damage to the cord indicates that the displacement at the time of the injury was more extensive than is subsequently found to exist (153).

The most common seats of fracture-dislocation are the lower cervical region (149), and about the junction of the dorsal and lumbar regions (155, 157). If the patient recover, the injured vertebræ become firmly united by bone, even though the displacement be considerable (157, 159).

Fractures of the odontoid process, and of other parts of the first two vertebræ, are very rare, and are usually immediately fatal (160).

In connexion with the question of operative interference in cases of fracture of

the spine, No. 149 shows that operation should be undertaken if, together with signs of fracture of the arches, there are symptoms of injury to the cord. If, on the other hand, the cord is crushed by a fracture-dislocation, little good can be expected from operation, as recovery of function does not occur even when the compression of the cord is instantly relieved by spontaneous reduction of the displacement (153).

149. A sagittal section of the lower five cervical vertebræ. A fracture runs obliquely downwards and backwards from the upper anterior edge of the body of the sixth (which is extensively comminuted) to a point in the body of the seventh 6 mm. below its upper and posterior border; the intervertebral substance between them, where crossed by this line, is torn. The anterior common ligament and the intervertebral substance above the sixth are also ruptured. The spinous process of the sixth has been broken across near its root, and the lamina of the fifth through its middle. The posterior fragments of the bodies project slightly backwards, and the detached lamina of the fifth slightly forwards, upon the spinal cord, the surface of which, about the seat of injury, is blood-stained from bruising of its substance.

From a man who fell backwards down three steps of a ladder. The accident was followed by paralysis, both of motion and sensation below the arms, respiration being diaphragmatic. The arms were flexed and, on being straightened, at once resumed their former position. There was tenderness over the fifth and sixth cervical spinous processes, and pain on manipulation. Pulse 56; respiration 16. Death occurred two days after the accident.

150. The lower six cervical vertebræ with the first two dorsal. The anterior portion of the body of the fifth cervical vertebra has been extensively crushed, apparently by forcible flexion of the neck; fragments of it, held together only by shreds of dried tissue, project in front, whilst posteriorly the body is divided into halves by a vertical fissure, and its lower border, in consequence of the bending forwards of the column, projects slightly within the spinal canal. The articular processes of the fifth and sixth vertebræ are widely separated, the posterior common ligament having been ruptured. The arch of the sixth cervical vertebra is fractured across its pedicles. 2652

151. The lower six cervical vertebræ; the spinous process of the sixth has been detached by a fracture through its base.

152. A sagittal section of the lower seven dorsal vertebræ, showing a fracture passing across the column through the body of the ninth vertebra, the upper part of which is displaced forwards upon the lower to such an extent that the spinal cord and dura mater have been completely divided; the anterior common ligament, however, is untorn, but has been stripped from the front of the vertebra below. The plane of the fracture passes obliquely downwards and forwards from near the middle of the upper surface of the ninth vertebra to its lower and anterior border; the spinous process of the eighth has also been detached. The pleura at the seat of fracture has been lacerated, apparently in consequence of the displacement; its surface is covered with a layer of exudation and the posterior surface of the anterior common ligament is covered with a similar layer.

153. The last four dorsal vertebræ, with the corresponding portion of the spinal cord. The body of the eleventh has been crushed, apparently with little displacement, the upper portion of the column slightly overlapping the lower. The body of the tenth vertebra has also been fractured in its left half. The edges of the fractured parts are smoothly rounded, but no new bone appears to have been formed in their neighbourhood. The dura mater is uninjured. The cord presents no evidence of damage externally, but, owing to the displacement of the column above the fracture forwards, the cord is pressed upon by the upper border of the eleventh vertebra. 140



The spinous processes were fractured, but there was no displacement of the bones beyond that shown in the specimen. The patient lived for thirty-eight days, paraplegic. It is probable that the spine was displaced at the time of the injury more than is now shown, and that the cord may have been crushed, although the dura mater is uninjured.

About a week after the accident the penis and scrotum became swollen, and finally extensive sloughing took place.

After death the bladder was found thickened and soft, and contained much mucus.

154. Seven dorsal vertebræ from the second to the eighth inclusive, with the spinous process of the first and adjoining parts of the ribs. A fracture-dislocation has occurred, involving the bodies of the sixth and seventh and the disk between them. The upper part of the column is displaced forwards; on the left side the upper articular process of the seventh vertebra is lying behind the lamina of the sixth, and the transverse process of the seventh has been detached. The laminae of all the vertebræ preserved in the specimen are fractured on the right side, and those of the fourth and eighth on the left side. The spinous process of the first has been broken through its extremity, and those of the second, fifth, and sixth through their bases.

155. The lower three dorsal with the first two lumbar vertebræ. The tenth dorsal has been dislocated forwards and to the left side after fracture of the body of the vertebra below. Posteriorly the arches have been sawn away, and the continuity of the spinal canal is seen to have been almost destroyed by the displacement. On the right side the eleventh rib was dislocated from the body of its corresponding vertebra and carried forwards with that above; the superior costo-transverse ligament is intact and has undergone ossification. The fracture itself is firmly united. 4112

156. The corresponding portion of the spinal cord and its membranes from the same case. Opposite the seat of displacement the cord has been completely torn through, the pia mater and arachnoid have been ruptured vertically, and all the membranes are inseparably adherent together at the level of greatest compression. The spinal cord, except in the neighbourhood of the injury, which is situated just above the lumbar enlargement, appears unaltered; in the recent state the damaged part was of a reddish colour and somewhat softened. 4113

From a man who whilst driving bent forwards in order to avoid a low archway, and was struck on the back of the head and carried backwards into the bottom of the vehicle. When brought to the hospital there was complete paraplegia. He lived for about three months after the accident, sinking at last from exhaustion increased by large bed-sores, which formed over the sacrum.

157. Part of a spinal column fractured through the last dorsal vertebra twenty-six years before death. The contiguous surfaces of the two portions of the spine have become firmly united by bone after displacement of the upper downwards and forwards upon the front of the lower. As a result of the displacement the upper portion of the spinal canal is occluded, whilst the lower is open and looks directly upwards: further displacement has apparently been prevented by the interlocking of the parts. Throughout the portion of the column preserved bony ankylosis has occurred extensively, in parts between the bodies of the vertebræ, in parts between the articular processes, and in the dorsal region between the ribs and the contiguous vertebræ. 5383

The patient, when 26 years of age, fell for a distance of 30 feet upon his abdomen, some bricks, from a wall he was pulling down, striking him afterwards upon the back. There was immediate paralysis of motion and loss of sensation in the lower limbs and in the trunk as high as the umbilicus. The patient left the hospital after three months. During the rest of his life the paralysis remained unchanged; urine dribbled away, and the bowels required opening by enemata every two or three weeks; otherwise he was in good health and well nourished.



158. Part of a spinal column, in which considerable deformity has occurred as the result of an extensive fracture of the body and arch of the first lumbar vertebra, the upper part of the column being displaced upon the front of the lower. The spines and arches of the last dorsal and first lumbar vertebræ are widely separated, the ligamenta subflava having been ruptured, and, in the interval, part of the dura mater lies exposed to view. Near the lower border of the last dorsal vertebra the dura mater has been torn across so as to expose the lower end of the spinal cord, the posterior part of which is ruptured. An incomplete circle of new bone has been formed around the edge of the fractured body. 3269

159. The lower four dorsal and first lumbar vertebræ, showing the complete repair of a fracture-dislocation through the lower part of the body and arch of the last dorsal after great displacement of the fractured parts. The upper part of the column, contrary to what is usual, is displaced downwards *behind* the lower, and slightly to the right side, and is so bent forwards as to form almost a right angle with that below; the lower portion of the spinal canal is thus occluded, whilst the opening of the upper looks downwards and backwards. Masses of compact bone occupy the angles resulting from the displacement, and aid in uniting the parts. The spinal canal below the level of the fracture is occupied by a thin bony tube, probably resulting from ossification of the theca. 3223

The patient was a man, 32 years of age, who fell 50 feet from a tree. He lived nine years and a half afterwards, with paralysis of the lower half of the body. No sloughing of the hips or back occurred, and blisters would heal, though slowly. He was subject to occasional attacks of cystitis and nephritis, from one of which he died.

160. An axis separated into two parts by a fracture passing through the superior articular surface on the left side and the posterior extremity of the lamina on the right side. Two small fissures run from the main fracture into the body. 7244

From a woman, æt. 39, who was found dead at the foot of a flight of 14 stairs. No other fractures were found.

#### FRACTURES OF THE STERNUM AND RIBS.

The *Sternum* is fractured usually by direct violence (161), but occasionally it is broken by forcible bending forwards of the body; the fracture is said also to have occurred from muscular action. The fracture is usually situated towards the upper part of the bone, and the upper fragment overlaps the lower. The manubrium may be separated from the body; this is sometimes spoken of as a dislocation.

The *Ribs or their Cartilages* may be broken by direct violence at any part; but more frequently the fracture results from the indirect violence of forcible compression of the chest. The fracture then usually occurs in the middle part of the rib, nearer the posterior than the anterior extremity (164), and most commonly involves one of the middle of the series. The fractures are frequently multiple (163).

Fractures of the first rib are very rare (167).

The most common complications of fractures of the ribs are wounds of the pleura and lung.

161. A sternum fractured transversely through the middle of its body, between the third and fourth costal cartilages. 5330

From a man over whose chest a brewer's dray passed, causing, in addition, fracture of some of the ribs. After death, which took place within ten days of the accident, one of the lungs was found to be ruptured, and air and blood had passed into the pleural cavity. The fracture of the sternum was not detected during life.

162. A sternum fractured transversely through the body at the level of the third costal cartilages. Posteriorly a scale of the upper fragment has been torn away and the periosteum stripped off as far as the manubrium. 3056

163. Eight ribs of the right side, from the second to the ninth inclusive. All of them, excepting the first and last, are fractured at one or more points in their length. The highest three, together with the last, of those broken present each a double fracture, the posterior taking a course obliquely downwards and forwards, whilst in the anterior the line of fracture is irregularly transverse; in the lowest the posterior fracture crosses the angle of the rib, and on the inner aspect is incomplete.
164. Three ribs, from different subjects, fractured in the neighbourhood of their angles, and united after varying degrees of displacement of their fragments. 3076
165. A fractured rib divided longitudinally, in which repair has taken place with deformity resulting from the displacement of the anterior fragment inwards towards the thoracic cavity. 3275
166. Part of the wall of the right side of the chest, with portions of six ribs all of which are fractured almost in the same vertical line. With one exception the posterior fragments project more or less inwards. Over four of the fractures the parietal pleura is torn, and the whole surface of the serous membrane is covered by a delicate layer of inflammatory exudation, most marked in the neighbourhood of the fractures. 5830
167. The first rib of the left side, showing a double fracture. The posterior fracture passes through the neck and is firmly repaired after overlapping of the upper surface of the smaller fragment by the larger one. The anterior fracture is parallel with, and immediately in front of, the groove for the subclavian artery. The fracture is ununited, and very little new bone is thrown out around it. 5612  
The clavicle and several other ribs were broken. An aneurism of the subclavian artery followed the injury and is preserved among the specimens of Aneurism.
168. Portions of two ribs repaired after fracture, and united across the intercostal space by a bridge of bone. 7192  
From a dissecting-room subject in whom there were extensive traces of old pleurisy with calcification of the adhesions.
169. The rib of a quadruped obliquely fractured and united after antero-posterior displacement of the fragments. The repair has been effected by an oval mass of new bone, along the middle of which a line of dried tissue indicates that one half has been produced around the contiguous point of each fragment, and that the union is not as yet completed. 3878
170. The first costal cartilage of the left side, with the adjoining part of the rib and sternum. The cartilage is almost completely ensheathed by a layer of bone; both bone and cartilage are interrupted across the middle by a layer of white fibrous tissue. In this position the bone surrounding the rib-cartilage forms a distinct ridge. A similar layer of fibrous tissue is present between the rib-cartilage and the sternum. 5928  
The specimen was obtained from the dissecting-room. A false joint between the first rib and its cartilage, or dividing the outer part of the cartilage, is not uncommon in cases in which there is much bone around the cartilage, and is probably developed as a compensation for the loss of mobility resulting from the ossification. (See Trans. Path. Soc. vol. xxxiv. 1883, p. 223.)
171. Parts of the cartilages of the 7th, 8th, and 9th ribs of the left side, showing repair after a transverse fracture through the 8th and 9th. The inner fragments overlap the outer on their anterior surface. The angles between the fractured ends are filled up in front with fibrous tissue and behind with bone. The projecting ends of the inner fragments are covered by a thick fibrous membrane. 7923



## FRACTURES OF THE BONES OF THE UPPER LIMB.

## FRACTURES OF THE CLAVICLE.

The clavicle is most commonly fractured about its middle (172). The displacement resulting is due:—1st, to the weight of the arm, which drags the outer fragment down below the level of the inner; and 2nd, to the contraction of the muscles passing from the trunk to the arm, which pull the outer fragment inwards beneath the upper: at the same time the tip of the shoulder is directed somewhat forwards, so that the inner end of the outer fragment is pointed slightly backwards (172). Fractures also occur between the conoid and trapezoid ligaments, when there is little displacement (179), and beyond the ligaments, when the outer fragment only is displaced, being rotated so that its outer end looks forwards and its inner backwards. Fractures also occur occasionally towards the sternal end (176).

172. Part of a manubrium with the two clavicles. The left clavicle has been fractured somewhat external to the middle, the fragments having become united in a bad position. The bone is considerably shortened in consequence of the outer fragment having been drawn inwards by the muscles passing from the trunk to the upper limb; and the weight of the limb has led to a displacement of the outer fragment below the inner; the inner fragment may also have been tilted upwards by the action of the sterno-mastoid muscle.

The sharp ends of the fragments are smoothly rounded, and their union is effected by two thick cylindrical bridges of new bone. Extensive deposits of new bone have taken place around the first rib-cartilage on each side.

173. A left clavicle fractured with slight obliquity at about the middle, and completely repaired after overlapping of the fragments and slight shortening, in consequence of dropping and falling inwards of the shoulder, and with it the outer fragment of the bone. 3021

174. A right clavicle repaired after a fracture which has occurred near the junction of its outer and middle thirds. The outer fragment has undergone displacement inwards and downwards so as to be overlapped by the inner, and is, in addition, slightly tilted forwards, its acromial articular surface coming to look less directly outwards than is normal. The edges of the two fragments have become smoothly rounded. From the under surface of the outer end of the inner fragment there projects an oval nodulated mass of osseous substance with a flattened inferior surface, apparently a part of the callus which has rested upon the coracoid process of the scapula. Both the articular ends of the bone have been affected with rheumatoid arthritis.

175. A right clavicle fractured with comminution somewhat external to the middle. The detached fragments, as well as the broken ends of the bone itself, are buried in, and held firmly together by, an oval mass of reticulated new bone. 3021

176. A right clavicle, greatly deformed from the displacement following a fracture near its sternal end, and close to the outer side of the attachment of the costo-clavicular ligament. As a result of the falling inwards of the shoulder, the end of the outer fragment is projected forwards and comes to lie in front of the inner. 3021

177. The sternal end of a right clavicle fractured obliquely outside the attachment of the rhomboid ligament, and repaired after displacement of the inner end of the outer fragment inwards and forwards. 5525

From the dissecting-room.



178. A left clavicle, repaired after a fracture close to the inner side of the attachment of the coraco-clavicular ligament. Considerable displacement and shortening have resulted from the falling inwards and dropping of the shoulder, the end of the outer fragment lying beneath the inner. The union is strengthened by a sheet of new bone formed within the angle resulting from the displacement. 3021
179. The outer half of a right clavicle which has been broken across between the parts of the coraco-clavicular ligament; beyond a sharp forward bend at the seat of fracture no deformity has occurred. 3021
180. A left clavicle fractured near its middle, in which, owing probably to movement of the fragments, no osseous union has been effected, although an abundance of new bone has been produced upon its broken ends. 3021

## FRACTURES OF THE SCAPULA.

The most common injury to this bone is a fracture separating the extremity of the acromion process (181), which may be repaired by fibrous tissue. Some of these fractures may result from separation of the acromial epiphysis, but generally the line of separation does not exactly correspond to the normal epiphysial line. Instances of detached acromion (the so-called *os acromiale*) are not unfrequently met with, in which, from the absence of displacement or other signs of injury, it would seem probable that the anomalous articulation has been formed spontaneously without fracture. Specimens illustrating these conditions are contained in the Anatomical Series. Fracture of the coracoid process is rare (187); it is said to have resulted from muscular action. All other fractures are the effect of considerable violence, and are irregular in character (182). The most frequent is perhaps a transverse fracture somewhere between the spine and the lower angle, the displacement being always slight (186). In rare instances fractures may involve the neck or glenoid fossa (182); the smaller fragment may then include the coracoid process (182, 185).

181. A left scapula the extremity of the acromion of which has been separated by a fall on the shoulder. In the recent state a false joint existed between the fragments. 200
182. A right scapula recently fractured. One fracture passes almost horizontally outwards from the junction of the middle and upper thirds of the glenoid fossa to the middle of the upper border of the bone, thus completely detaching the coracoid process. From the middle of this fracture a fissure passes vertically downwards into the body of the scapula for 4 cm., and ends by turning up in a U-shape. The acromion process has also been fractured at its junction with the spine. 4980
183. A right scapula which has been completely separated into two parts by a transverse fracture passing from a point immediately below the glenoid fossa to a point in the vertebral border at the lower angle of the triangular surface at the root of the spine. The alteration in the shape of the acromion process has resulted from disease of its articulation with the clavicle. 3102
184. A right scapula extensively fractured as the result of direct violence. One fracture crosses the bone transversely in exactly the same position as in the last specimen. From this fracture several fissures pass downwards to the axillary and vertebral borders, and another extends upwards across the spine through the supraspinous fossa, and is joined by a fissure beginning at the great scapular notch. 5382

The injuries were sustained in a railway accident; several other bones were broken, and there were also internal injuries.

185. A left scapula extensively fractured as the result of a railway accident. One fracture crosses the bone transversely above the spine, and is joined by another running into the upper border, thus completely detaching the coracoid process. The acromion process has been detached at its junction with the spine, and numerous fissures run through the body of the bone. 5381
186. A left scapula in which an irregularly transverse fracture of the body has been repaired after overlapping of the upper fragment by the lower, posteriorly. 3092
187. Parts of the scapula and clavicle of the left side. The extremity of the coracoid process has been detached by a fracture, and is united to the rest of the bone by a thick band of fibrous tissue. 5547
- From the body of an old woman, in the dissecting-room.

### FRACTURES OF THE HUMERUS.

Fractures of the humerus occur (1) about its head and neck, (2) in the shaft, and (3) at its lower extremity.

1. (a) Separation of the great tuberosity; the fragment is displaced backwards and upwards beneath the acromion by the muscles attached to it (188, 189).  
 (b) Fracture of the anatomical neck (190). This is very rare; it may be impacted.  
 (c) Fracture of the surgical neck. In this the displacement is very marked. The upper fragment is abducted and rotated outwards by the muscles attached to the great tuberosity. The lower fragment is drawn inwards by the pectoralis major, latissimus dorsi, and teres major, and upwards into the axilla by the biceps, triceps, coraco-brachialis, and deltoid (191, 192). This fracture may be impacted.  
 (d) Separation of the upper epiphysis.
2. Fracture of the shaft is usually oblique, and occurs above or below the attachment of the deltoid. That fragment to which the deltoid is attached is displaced outwards (197).
3. (a) Fracture of the inner condyle.  
 (b) Fracture separating one condyle and extending into the joint.  
 (c) Fracture taking a T-shape, separating both condyles from the shaft and from each other (199).  
 (d) Separation of the lower epiphysis.

In *c* and *d* the lower fragments are always displaced backwards with the bones of the forearm.

188. The upper part of a left humerus, together with the scapula and parts surrounding the shoulder-joint. The great tuberosity of the humerus has been broken off by direct violence, and the upper part of the capsule ruptured. 5016
189. A left scapula with the upper part of the humerus. The great tuberosity of the latter has been detached and is wanting. The subscapularis muscle has been torn from its insertion. 3085

W. R., a man æt. 50, was admitted into the London Hospital, under the care of Mr. Henry Thomson, on Dec. 6, 1760, having received an injury to the shoulder by the sudden recoil of a wheel used in twisting a rope. There was a considerable hollow under the acromion; the elbow was somewhat elevated and turned outwards, and could not be brought to the side of the body; the head of the humerus could be felt high up in the axilla. Attempts to reduce the dislocated head were made, but without success. The patient died on Dec. 24, from "a fever, attended with a violent sore throat."

*Post mortem*, the head of the humerus was "found lodged on the inside of the neck of



the scapula, at the root of the coracoid process" "The capsular ligament had been completely torn from the humerus." The upper end of the humerus had been fractured, and "the attachments of the supra- and infraspinatus muscles were torn off with the part of the bone they were inserted into;" the detached portion of bone appears to have been separated into fragments. ('Medical Observations and Inquiries,' 1762, vol. ii. p. 340.)

190. A right scapula and humerus. The head of the humerus is wholly wanting, in consequence, probably, of having been detached by a fracture of the anatomical neck. The inner surface of the tuberosities, concave and deeply cleft across the middle, is coated with a thin layer of compact bone. The humerus bears marks of having been affected with rickets.  
The anterior and posterior margins of the glenoid fossa of the scapula are smoothly rounded, the articular surface being convex antero-posteriorly, though it remains concave in the vertical direction.  
The articular surface is formed by a layer of compact bone resembling that which has been formed upon the upper end of the humerus. 3051  
It is stated that the changes were the result of injury.
191. A left humerus fractured through its surgical neck and repaired after slight displacement of the shaft forwards and inwards. The line of fracture runs downwards and backwards from immediately below the small tuberosity to a point 6 cm. below the lower margin of the head; a shallow V-shaped furrow on the posterior aspect marks the obliquity of the injury. 5184
192. The left humerus of an old person, fractured at some time in the same manner as the preceding, and repaired after similar displacement. The whole bone is exceedingly atrophied, the cancellous tissue of its interior having been almost wholly removed. The upper extremity is flattened laterally, and the size of the head is somewhat diminished. In consequence of the displacement the bicipital groove presents a shallow S-shaped curvature, within the concavities of which its edges are raised by bony outgrowth. 3137
193. The upper half of the left humerus of an old person, recently fractured in an irregular transverse line through its surgical neck; portions of the wall have also been detached. 1759
194. A left humerus which has been fractured obliquely and with comminution through its upper third, and in which the parts are firmly consolidated. A fragment, 7 cm. long, sharply pointed below, and firmly united with the rest of the bone, projects prominently from its outer side, apparently after having been displaced by the action of the deltoid. 3880
195. A left humerus fractured obliquely downwards and inwards through its upper third, and from the outer aspect of which a portion, 15 cm. in length, reaching from the greater tuberosity to the middle of the shaft, has been split off. Except at the lower posterior margin of the fragment, and for a short distance anteriorly in the line of the other fracture (where intervals exist between the fragments), all the parts are firmly blended, and their union is strengthened by masses of new bone. 3177
196. A right humerus divided longitudinally, showing a transverse fracture through the middle of its shaft. Union has occurred after angular displacement of the fragments forwards, and rotation of the lower fragment inwards. The medullary canal at the seat of injury is still occupied by the remains of the internal callus. There is a deep groove in the new bone on the inner surface, apparently for the passage of the ulnar nerve. 3138
197. A left humerus showing repair after an oblique fracture through the middle of its shaft. Some outward displacement of the upper of the fragments,



due to the action of the deltoid, has occurred, whilst the lower has been drawn upwards and tilted forwards so as to overlap the former. A columnar mass of new bone, almost as thick as the shaft itself, with a similar surface, and about 7 cm. long, connects the fragments on their inner aspect, bridging the angle which has resulted from the displacement. The musculo-spiral nerve probably passed along the groove and through the canal on the posterior surface. 3882

198. A right humerus, divided longitudinally, showing repair of an oblique fracture through the lower third of its shaft. The lower fragment is greatly increased in size, and its texture very close, owing to long-continued inflammation arising from necrosis of a portion of its cancellous tissue. The central cavity in which the sequestrum lay opens on the outer aspect of the bone by a rounded aperture. The medullary cavity in the neighbourhood of the fracture is filled with new bone, and a considerable deposit has occurred on the posterior surface of the upper fragment. 3885

There is no history to the specimen, but the fracture was in all probability a compound one.

199. The lower half of a left humerus, with parts of the radius and ulna. The humerus is transversely fractured about 2 cm. above the inner condyle, and its lower fragment split vertically by a fracture leading downwards into the elbow-joint along the groove between the capitellum and the trochlear surface; together the lines of fracture have the form of the letter T. A portion which was detached from the front of the inner of the lower fragments is missing. The only signs of repair consist in a slight deposit of bone on the upper fragment, and the rounding off of some of the fractured edges. 3725

From a man who fell 12 feet from a ladder. The fracture was compound. Suppuration within the joint and escape of pus by the external wound followed. The limb was amputated four weeks after the accident. The patient recovered.

200. A plaster cast of a left elbow, showing the deformity resulting from a T-shaped fracture of the lower end of the humerus. Viewed from the outer side, three distinct prominences, placed vertically one above the other, are recognizable. The upper of these is the external condyle, the middle the olecranon, and the lowest, which forms a marked projection, is caused by the displacement of the inner portion of the lower extremity of the humerus. 5791

#### FRACTURES OF THE ULNA.

Fractures of the ulna may occur at any part, usually from direct violence (205). The olecranon is often broken off by falls or blows on the elbow. It is drawn upwards by the action of the triceps and seldom unites by bone (201, 203). This fracture implicates the articular surface.

201. The upper ends of the bones of a left forearm. The olecranon has been detached by a transverse fracture through its lowest part, and shows no signs of bony union. A fracture has also occurred in the head of the radius, the outer part of which is united to the rest of the bone, with considerable displacement outwards. The edges of the several articular surfaces are bordered with bony outgrowths, the result of rheumatoid arthritis. 4584

The fracture of the olecranon was probably united by fibrous tissue.

202. The bones of a right elbow-joint, in which the olecranon has been detached by fracture. The fracture was comminuted, and a considerable fragment is missing. 4584

203. The bones of a left elbow-joint. The olecranon process of the ulna has been detached by a fracture passing from behind the coronoid process obliquely downwards and backwards through the anterior part of the joint, and along the posterior part of the small sigmoid cavity. About 3 cm. beyond this the shaft of the bone has, in addition, sustained a comminuted fracture. In the recent state the highest of the fragments was extended to its utmost by the contraction of the triceps; the middle fragment was drawn upwards and displaced upon the front and lower part of the humerus by the brachialis anticus; further, the head of the radius was dislocated forwards and lay upon the lower end of the shaft of the humerus.
204. The bones of a right elbow-joint in which fractures have involved the olecranon and coronoid processes of the ulna and the head of the radius. The two detached processes of the ulna have become firmly united after considerable displacement downwards and forwards. A considerable mass of bone has been thrown out around the coronoid process, and the displacement of the olecranon has greatly encroached upon the great sigmoid cavity. The fracture of the radius has separated the outer third of the head, and the fragment has united after displacement downwards for 1.5 cm. An irregular deposit of bone is present around the articular surface of the humerus on its posterior aspect. The forearm bones were displaced backwards so that the articulation with the humerus is formed only by the detached fragment of the coronoid process and the head of the radius, with the surrounding callus, the radius being fully pronated.
205. A right ulna fractured across the middle of its shaft, and united after antero-posterior overlapping of the fragments, the lower of which lies in front of the upper. 4982
206. A left ulna fractured obliquely at the junction of the middle and lower thirds, and repaired with scarcely any deformity. 4966
207. A left ulna fractured transversely at the junction of its third and lowest fourths, and firmly repaired with angular deformity outwards. 4966

#### FRACTURES OF THE RADIUS.

Fractures of the Radius may involve the shaft or either extremity, more frequently the lower.

1. Upper extremity.
  - (a) Longitudinal of head (201, 204).
  - (b) Fracture of neck.
2. Shaft.
  - (a) Above the insertion of the pronator radii teres. In this fracture the upper fragment is supinated (208, 209) and consequently the hand must be kept in a similar position during the process of repair. Want of attention to this point will result in the union of the two fragments in different positions of rotation, and partial or complete loss of the power of supinating the hand.
  - (b) Below the insertion of the pronator radii teres. In this fracture the upper fragment, being acted upon both by pronators and supinators, is brought into a mid-position, and consequently the hand must be kept in this position during the process of repair.
3. Lower extremity.

The most frequent and important injury to this part of the bone is that known as Colles's fracture. This is always the result of indirect violence from falls on the extended hand. The fracture occurs transversely within 3 cm. of the articular surface (212 *et seq.*). The lower fragment is displaced backwards with the carpus, and at the same time the compact tissue of the posterior part of the upper fragment



is driven into the cancellous tissue of the lower, and may become firmly impacted (214). The anterior edge of the upper fragment projects sharply in front. The impaction shortens the radius and causes displacement of the hand to the radial side (212).

208. A left radius obliquely fractured through the upper third of its shaft, a short distance below the tuberosity. Union has occurred after displacement of the lower fragment inwards, backwards, and upwards behind the upper, and after supination of the upper fragment and pronation of the lower.

209. A right radius and ulna, the former of which has been fractured obliquely above the middle of its shaft. The union is somewhat angular, and whilst the upper fragment is supinated the lower is strongly pronated. 3192

It is highly probable that the fracture was compound, since the ulna, although showing no signs of having been fractured, is altered in shape by an inflammatory deposit of new bone opposite the seat of injury.

210. The radius and ulna of the left side, the former of which has been repaired with very slight deformity after an oblique fracture through the middle of its shaft. New bone has been formed on the adjacent part of the ulna, and a false joint existed between this and a projecting mass of callus on the radius. The lower end of each bone has also been fractured and is firmly repaired with slight deformity. 5857

From the dissecting-room.

211. Cast of a left forearm and hand, showing a considerable dorsal prominence resulting from the faulty repair of a fracture of the lower half of the shaft of the radius. 5724

212. The bones of a right hand and forearm, with their ligaments. The radius has been fractured transversely within 2 cm. of its lower extremity (Colles's fracture). Union has occurred after considerable displacement of the lower fragment, the malposition of which has been almost unrelieved by treatment. This fragment, together with the hand, is displaced backwards and somewhat outwards, and is at the same time turned on its transverse axis, so that its carpal articular surface is directed backwards as well as downwards.

The displacement of the lower fragment with the carpus gives rise to the dorsal prominence seen in Colles's fracture; the lower end of the upper fragment projects sharply forwards, occasioning the prominence on the palmar aspect. The styloid process of the ulna, owing to the outward displacement of the hand, is more prominent than natural.

213. A left radius repaired after a fracture across its shaft within 2.5 cm. from its lower end (Colles's fracture). The deformity which has resulted is identical with that in the preceding specimen, the lower fragment being both displaced and rotated backwards, and, in addition, carried outwards so as to form a marked projection upon the outer border of the lower end of the bone.

214. A similar specimen, showing, however, less outward displacement and turning back of the lower fragment. The section which has been made of the fractured part shows the posterior wall of the upper fragment to have been impacted into the cancellous tissue of the lower.

215. A right radius repaired after having been fractured across the lower part of its shaft, close above the articular end. The lower of the fragments is slightly displaced behind the upper. 4265

216. Cast of a right hand and lower half of the forearm, from a case of Colles's fracture. The deformity shows the displacement of the parts to have corresponded closely with that in No. 212.



The lower fragment of the radius, together with the carpus, is displaced backwards, forming a gradually raised projection upon the dorsal aspect of the forearm, and also outwards, the hand being somewhat abducted. The end of the ulna, in consequence of the outward displacement of the hand, stands prominently out beyond the ulnar border of the latter. A more marked swelling, caused by the end of the upper fragment, exists upon the palmar aspect immediately above the wrist.

217. Cast of a left hand and adjoining part of the forearm, showing the deformity resulting from Colles's fracture. On the dorsal aspect of the limb is a well-marked prominence caused by the displacement of the carpus with the lower fragment of the radius backwards. On the anterior aspect at a somewhat higher level is a less marked projection corresponding to the lower end of the upper fragment of the radius.

#### FRACTURES OF THE RADIUS AND ULNA.

These occur from indirect or direct violence, and are most common in the lower half of the bones (218). Occasionally, as the result of improper treatment, the two bones become united by a mass of callus between them.

218. A right radius and ulna fractured about 4 cm. above their lower ends. The fractures have united after a slight displacement of the lower fragments backwards and inwards, the interval between them being preserved unaltered. 3994

219. The bones of a left forearm, each of which is the seat of an ununited fracture above the middle of the shaft. The several fragments are enveloped in irregular masses of nodulated new bone; marked angular deformity backwards is present in each bone, the lower fragment of the radius lying to the inner side of the upper one. 3096

The fracture was compound, and was probably followed by necrosis.

220. Cast of the left hand and forearm of a child, in which a fracture of the radius and ulna near their middle has united with angular displacement of the fragments towards the ulnar side.

221. Cast of a right hand and adjoining part of the forearm, from a case of fracture of the lower end of the radius, showing marked displacement of the lower fragment, with the hand, backwards upon the upper. The lower end of the upper fragment, covered by the flexor tendons, forms a smooth elongated swelling in front of the forearm immediately above the wrist-joint. The displaced lower fragment forms an equal, though more abrupt, swelling on the dorsal aspect. The lower end of the ulna appears also to have been fractured.

#### FRACTURES OF THE BONES OF THE HAND.

Fractures of the metacarpal bones result usually from blows on the knuckles of the closed fist, and occur most frequently in the distal half of the bones. Simple fractures of the phalanges, resulting mostly from direct violence, are not common.

222. The phalanges of one of the fingers. Through the base of the second phalanx on one side a fracture has extended into the first interphalangeal joint, the articular surfaces of which have, in part of their extent, been destroyed by ulceration. The fragments are partially united by bone. 2951

## FRACTURES OF THE BONES OF THE LOWER EXTREMITY.

## FRACTURES OF THE PELVIS.

These occur almost always as the result of violent compression.

In this case it is most common to find the line of fracture crossing the rami of the pubis and ischium and the thyroid foramen in front, while posteriorly the sacro-iliac articulation of the opposite side is often torn through (226, 227). More irregular fractures are, however, not uncommon (228). When the inferior ramus of the pubis is implicated and the two sides are pressed forcibly together, the upper end of the fractured ramus may be driven in under the pubic arch and tear the urethra.

Fragments of the iliac crest are sometimes broken off by direct violence (223, 224).

Fracture of the brim of the acetabulum occasionally complicates dislocation of the hip-joint, and in very rare instances the floor of the acetabulum has been broken.

**223.** A left hip-bone, from the iliac part of which an elongated portion of the upper border, extending from the anterior superior spine to the back of the iliac fossa, has been detached by a fracture, and has united with the rest of the bone after slight displacement downwards within the fossa. A nodulated ridge of new bone projects directly outwards from the edge of the main fragment. 3039

**224.** The right half of a pelvis. From the iliac part of the hip-bone a portion, including almost its upper half, has been detached by a fracture; union has occurred after slight inward displacement of the fragment.

The upper part of the anterior sacro-iliac ligament is ossified.

**225.** The anterior half of a pelvis fractured on each side almost symmetrically across the thyroid foramen. Above, the fracture passes through the front of the acetabulum from the ilio-pectineal eminence to the cotyloid notch, and below, through the lower part of the ramus of the ischium. On the left side there is, in addition, an incomplete fissured fracture of the superior ramus of the pubis. 4750

The injury was caused by a brewer's dray passing over the pelvis.

**226.** The pelvis of a young subject fractured almost symmetrically across the thyroid foramen on each side. Above the foramen the fracture passes through the outer end of the superior pubic ramus, and below, through the ischio-pubic rami. On the right side the lower fracture is 2 cm. below the lower border of the symphysis, and in addition there is an incomplete fracture at the lower part of the ramus of the ischium. A small fragment has been detached from the anterior border of the auricular surface of the sacrum on the left side, showing that the sacro-iliac articulation on this side was torn open. 5362

**227.** A pelvis fractured in the same situation as the preceding, but on the right side only; the fracture of the superior pubic ramus is incomplete posteriorly. Portions of the margin of the auricular surface of the sacrum on the left side have been broken away by forcible separation of the articulation; and a sixth segment of the sacrum has been detached from the rest of the bone. 3020

**228.** An oblique pelvis, showing repair of an extensive fracture. The obliquity of the pelvis is associated with the presence of a lumbo-sacral vertebra, which has in its left half the characters of a sacral vertebra.

On the right side a fracture passes through the ilium in a line from the sacro-iliac articulation to the anterior inferior iliac spine, the upper part of the bone being slightly displaced to the outer side of the lower, and the outer angle of the ala of the sacrum being impacted between the two fragments. Repair is complete, and there is bony ankylosis between the sacrum and ilium.

On the left side a fracture passes vertically through the sacrum. Inferiorly a



narrow strip of the sacrum is separated to the extent of a finger's breadth from the rest of the bone; whilst superiorly the position of the fracture in the lateral mass of the lumbo-sacral vertebra is marked by a prominent ridge of callus which at its upper part forms a false joint with the lower border of the transverse process of the last lumbar vertebra. In the position of the first anterior sacral foramen are three separate openings leading into the sacral canal and separated one from another by smooth rounded bars of bone.

The left hip-bone has also been crossed by a fracture at the junction of its ischial and pubic rami. A considerable amount of bone has been thrown out about this fracture, and the obturator membrane has undergone partial ossification.

229. The lower half of a left hip-bone and the upper part of the femur extensively fractured. Separate fractures pass through both rami of the pubic bone, and through the tuberosity and adjacent part of the ramus of the ischium. From the fracture through the inferior pubic ramus a fissure runs upwards along the posterior border of the symphysis. The anterior portion of the border of the acetabulum has been completely detached. The femur shows a comminuted fracture of the anterior surface of the great trochanter, from which three fissures pass downwards, one through the posterior surface of the neck and across the small trochanter, a second nearly vertically in front of the anterior intertrochanteric line, and a third spirally through the gluteal ridge and onwards to the lower end of the part of the shaft preserved. Fragments of cartilage and bone have been detached from the upper border of the articular surface of the head, and a fissure runs inwards towards the depression for the round ligament. 5607

#### FRACTURES OF THE FEMUR.

Fractures of the femur occur (1) about the head and neck, (2) in the shaft, and (3) about the lower articular end.

1. (a) Separation of the great trochanter.
- (b) Intracapsular fracture of the neck of the femur. This usually occurs from indirect violence in old people, in whom, from interstitial absorption, the neck is altered in form so as to be set more nearly at a right angle with the shaft than natural. At the same time the bone is usually much atrophied (231). The neck may in very rare cases be impacted into the head (237). Bony union occurs rarely (237), but firm fibrous union may result, or a false joint may be formed (233). In young subjects separation of the head may occur through the epiphysial line.
- (c) Extracapsular fracture of the neck of the femur occurs usually from direct violence applied to the trochanter. In young and healthy bones it is usually accompanied by much comminution and sometimes by impaction of the neck into the trochanter, the impaction being loose on account of the amount of splintering of the bone (241). In the atrophied bones of old people the fracture is frequently immediately outside the attachment of the capsule, and the neck is deeply impacted into the trochanter (238, 4, 243). Union of extracapsular fracture takes place by bone (242). The chief displacements are shortening and rotation outwards (243, 249).
2. Fractures of the shaft from direct violence occur at any part, and are usually irregularly transverse (251, 263). Fractures by indirect violence occur most frequently near the junction of the upper and middle thirds of the bone. The line of fracture is most commonly oblique from behind, forwards and outwards. The upper fragment is abducted, slightly flexed, and somewhat rotated outwards; the lower is drawn upwards behind and slightly internal to the upper, and is greatly rotated outwards (254). In rare cases of fracture high up the lower fragment is displaced in front of the upper (252, 47).



3. In fractures of the lower end of the femur either condyle may be separated, or a T-shaped fracture may detach both condyles from the femur and from each other (275, 276). The whole lower extremity of the femur may be separated from the shaft by a transverse fracture. Under these circumstances the lower fragment becomes forcibly flexed into the ham by the action of the gastrocnemius. In one specimen (283) a fissure extends vertically from between the condyles.

In complete separation of the lower epiphysis of the femur the end of the shaft usually projects backwards into the popliteal space.

## INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR.

230. The upper end of a left femur, the neck of which has been fractured within the capsule immediately beyond the articular surface of the head; the plane of the fracture is irregular, a wedge-like portion of the neck remaining in connexion with the separated head. The fragments are held together by portions of the prolongation of the capsule upon the neck, which remain untorn and effectually prevent upward displacement of the shaft, slight eversion being the only displacement possible; a piece of whalebone has been passed beneath the lowest of these untorn portions. The periosteum has been partially stripped from the upper part of the lower fragment, carrying with it a scale of the subjacent bone. The capsule of the joint is entire. 4577
231. The upper ends of the femora, from a woman between sixty and seventy years of age; the right femur has been fractured in a zigzag line across the root of its neck, and close within the line of attachment of the capsule of the hip-joint. 4204
232. The upper part of a left femur, in which an intracapsular fracture has occurred. The head of the bone retains a connexion with the neck by means only of a slender band of untorn periosteum, with which some scales of osseous substance have been detached. Upon the centre of the surface presented by the fractured neck there is a smooth raised spot crusted with cartilage—a detached portion of the upper border of the articular surface of the head, which has been impacted near the middle of the fractured neck. 4048
233. The upper end of a left femur, the neck of which has been fractured within the capsule. No bony union has occurred, but the fragments are held together by three flattened ligamentous bands each about 2.5 cm. in length, and their fractured surfaces, slightly undulating and mutually adapted, are covered with a thin glistening layer of very dense fibrous tissue. The neck of the femur has been completely removed by absorption, the detached head being connected with the upper end of the shaft. The lower part of the capsule is greatly increased in thickness, and has aided in transmitting the weight of the trunk to the upper end of the shaft of the bone.
234. The upper part of a left femur, the neck of which has been fractured in an uneven transverse plane close to its junction with the head, and within the line of attachment of the capsule. The cancellous spaces on the fractured surface of the head are closed with new bone, and the posterior part of the fractured surface of the neck shows a similar change. Considerable loss of substance has occurred in the neck, and probably the fragments were held together by fibrous tissue. 4316
235. The bones of a left hip-joint, in which the head of the femur has been detached from the neck by an intracapsular fracture. The femur is displaced upwards, and

the only part which remains in contact with the fractured surface of the head is a small mass of new bone thrown out in front of the small trochanter and the surface of the femur immediately above it. The fractured surface of the neck, which has undergone considerable absorption, lies altogether above the upper border of the acetabulum, and articulates with the concave under surface of a considerable mass of new osseous tissue which has been thrown out on the dorsum of the ilium. A considerable degree of movement appears to have been possible in the latter situation. It is evident from the position of the parts that the limb was strongly adducted. 3079

**236.** The upper end of a left femur, in which an intracapsular fracture of the neck has remained ununited by bone. The line of fracture corresponds posteriorly with the border of the articular cartilage, and in front passes through the middle of the neck. As the result of a deep impaction of the compact tissue of the posterior surface of the neck into the substance of the head, great rotation of the shaft outwards has resulted. The fractured surfaces are mutually adapted, and new bone has been thrown out on the surfaces of the fragments. 4988

**237.** The upper end of a right femur, showing firm union by bone of the fragments resulting from an intracapsular fracture; the shaft has been drawn upwards for about 3 cm. Posteriorly the union is direct; anteriorly, where the parts have not been in apposition, union has been effected by a flattened bridge of new bone passing between the line of the capsular attachment and the margin of the head, and corresponding in position with the untorn reflection of the capsule, such as is seen in No. 230.

The lower edge of the neck appears also to have been impacted into the head. 206

#### EXTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR.

**238.** The upper end of a left femur, the head and neck of which have been separated from the shaft by a fracture passing outside the line of attachment of the capsular ligament, through the great trochanter, and below the small, in a plane parallel with the intertrochanteric lines. A second fracture, commencing in front of the small trochanter, half encircles the root of the neck posteriorly, passing close above the posterior intertrochanteric line and entering the first at its highest point so as to isolate the head and neck from the rest of the bone; this fracture is concealed by the thickened fibrous tissue covering the parts, which, whilst it hides the fracture from view, holds the fragments closely applied. A limited amount of fibrous union has taken place in the line of the first fracture at its upper end. 3638

The patient, a woman over 80 years of age, received the injury from a fall on the hip. No shortening of the limb was evident when she was admitted to the hospital, but subsequently some occurred. Death took place about ten weeks after the accident.

**239.** The upper part of a left femur fractured in a manner almost identical with that shown in No. 238. The small trochanter is, however, also separated from the great trochanter. 4267

**240.** The upper end of a left femur fractured in a manner similar to No. 238 except that the line of fracture posteriorly passes above instead of below the small trochanter. 3012

**241.** The upper end of a right femur, in which an extracapsular fracture has occurred, the line of fracture running exactly round the root of the neck. By the impaction



of the neck into the trochanter the upper end of the bone has been splintered into two fragments: the posterior of these includes part of the great trochanter, the whole of the small trochanter, and a triangular portion of the posterior part of the shaft nearly 5 cm. in length; the fragment in front is formed by the anterior half of the great trochanter. 3012

242. The upper ends of the femora from the same person, the left united after an extracapsular fracture of its neck, which is impacted into the cancellous tissue of the great trochanter. The posterior part of the great trochanter, together with a portion of the small trochanter, has also been detached, but is now, after slight displacement backwards, firmly united to the upper end of the shaft. The section shows the compact tissue of the neck to have been driven far into the upper part of the shaft, the medullary canal of which is filled with new bone. A comparison with the opposite bone will show how slight has been the shortening, and that there is a complete absence of eversion. 3711

The patient was 80 years of age. The injury resulted from a fall on the hip.

243. The upper end of a right femur, from an aged subject, in which an extracapsular fracture involving the trochanters has firmly united after impaction of the detached neck into the cancellous substance of the great trochanter; the posterior part of the trochanter is flattened, having been apparently driven inwards and forwards upon the neck.

The angle of union between the neck and the shaft is acute; and from the amount of displacement, the limb must have been considerably shortened. An excess of new osseous tissue has been produced within the angle of the neck and overhangs the shaft below. 4988

The injury was occasioned by direct violence, the patient having fallen on the hip.

244. The upper end of a right femur, in which an extracapsular fracture of the neck has united with considerable deformity. The summit and posterior half of the great trochanter have also been separated and are missing. The shaft of the femur has been displaced backwards and upwards, and rotated outwards; the anterior border of the neck overlaps the adjoining surface of the shaft, projecting forwards inferiorly for nearly 2 cm., whilst its posterior border is deeply impacted in the cancellous tissue of the undetached portion of the great trochanter. The outward rotation of the shaft amounts to about 45°, and the shortening to nearly 2 cm. 4988

245. The upper end of a left femur, with the adjoining part of the shaft, greatly deformed by the displacement following a fracture across the root of the neck, and a second fracture passing through the upper end of the shaft downwards and outwards from immediately above the small trochanter. The fracture through the neck has been repaired after backward displacement and rotation outwards of the great trochanter. The chief displacement, however, is of the shaft, which has been drawn upwards, forwards, and inwards, the bone being shortened to the extent of 2 cm. by the overlapping of the fragments, which are firmly consolidated, partly by union of their contiguous surfaces, partly by means of a mass of new bone bridging across the interval between the pointed end of the upper and the outer surface of the lower fragment. There is no outward rotation of the shaft. 3881

246. The upper part of a left femur, showing great deformity following an extracapsular fracture of the neck, which is in process of repair. The great trochanter has also been detached. The upper end of the shaft, with which the small trochanter remains united, has been displaced forwards so as to form an obtuse angle with the neck, and the shaft is rotated outwards for nearly a quarter of a circle.



The great trochanter has been doubled backwards so as nearly to touch the head; and irregular masses of new bone have been produced along the lines of fracture.

4268

247. Plaster cast of a hip-bone and the upper half of the femur, the latter repaired after an extracapsular fracture of its neck. An excessive amount of new bone has been formed upon the ends of the fragments, the lower of which has been slightly displaced upwards, flexed and rotated outwards, and so abducted as to lie almost at a right angle with the trunk.

#### FRACTURES OF THE FEMUR THROUGH THE TROCHANTERS.

248. A right femur, the upper end of which has been broken into three fragments by two very oblique fractures, and repaired after slight displacement of the shaft upwards and forwards. One of the planes of fracture has passed downwards and backwards from the anterior intertrochanteric line through the middle of the great trochanter and the posterior part of the shaft, extending 4 cm. below the small trochanter; the other has detached from the outer aspect of the bone a splinter, including the anterior part of the great trochanter, and a tapering portion of the wall of the shaft about 13 cm. in length. The shaft is rotated slightly inwards.

3323

249. A right femur, the upper extremity of which has been detached from the shaft by a fracture passing in an antero-posterior plane obliquely downwards and inwards close beyond the line of the anterior intertrochanteric line, through the posterior half of the great trochanter and the wall of the shaft on its inner aspect for about 5 cm. below the small trochanter. The chief displacement is an outward rotation of the femur below the line of fracture; the rotation amounts to nearly 45°.

3323

#### FRACTURES OF THE SHAFT OF THE FEMUR.

250. The upper part of a left femur, fractured with slight obliquity downwards and backwards across the highest part of its shaft; in front of the small trochanter the line of fracture has passed above and within the boundary of the joint. The upper fragment is very light, and its cancellous tissue uniformly exposed at every part except on the outer aspect of the great trochanter and the head of the bone; the lower fragment is unaltered.

There is scarcely a trace of new bone formed upon the ends of the fragments. The condition of the upper fragment has most probably resulted from atrophy.

4252

251. The upper two-thirds of a right femur, showing a recent comminuted fracture of its shaft, which has passed irregularly across it close below the small trochanter. A portion, about 7 cm. long and including about half the diameter of the shaft, has been separated from the inner side of the main fragment.

3992

252. The upper end of a left femur, presenting a smoothly rounded angular bend, the result of a fracture through its shaft immediately below the small trochanter, which has been repaired after displacement of the fragments. The upper fragment is in a position of flexion, abduction, and slight rotation outwards, and is overridden by the lower. There is scarcely any rotation outwards of the shaft.

4264

253. A right femur, fractured obliquely through the upper third of its shaft and repaired after slight displacement forwards of the ends of the fragments

The plane of fracture passes from the lower margin of the neck obliquely downwards and outwards. The neck forms almost a right angle with the shaft; this is probably due to old age. 3704

254. The upper half of a left femur, fractured with slight obliquity downwards and forwards through its shaft, about 5 cm. below the small trochanter; the fragments are firmly consolidated, and their ends smoothly rounded off. The displacement present in this specimen is that usually seen in fractures in this situation when not relieved by treatment. The upper fragment is flexed by the iliopsoas, and is abducted and rotated outwards by the muscles attached to the great trochanter; the lower fragment is drawn upwards behind the upper by the hamstring muscles, and rotated outwards by the weight of the limb. 3178

255. A left femur, which has been repaired after overlapping of the fragments resulting from a fracture across its shaft at the junction of its upper and middle thirds. The upper fragment is in a position of slight flexion and abduction; the lower is drawn upwards behind it and slightly to its inner side, so as to make the bone shorter by about 5 cm. 4852

256, 257. Two femora, from the same person. The left has been broken across its shaft at the junction of its upper and middle thirds, and has united after such displacement that the upper fragment crosses the lower at a right angle.

The upper fragment is semiflexed, in part from the action of the ilio-psoas, but chiefly from the drawing upwards of the lower fragment behind it by the hamstring and adductor muscles. The projecting end of the upper fragment, which overhangs the bone below for almost 2 cm., is smoothly rounded, and its medullary cavity closed over by a layer of compact osseous tissue; and the angle in front of the displaced fragments is filled with a wedge-shaped mass of new bone as broad as the shaft itself. The shortening amounts to nearly 10 cm. 4981

258. The upper two-thirds of a left femur, the shaft of which has been fractured obliquely downwards and inwards about its middle. Viewed from the front the fracture forms a very perfect spiral, which at its upper end is continued as a fissure into the posterior wall of the upper fragment passing through the gluteal ridge and small trochanter. There is little evidence of repair except in the fissure last described. 4256

From a man, 86 years old, who met with the injury by falling down in his room. He died four weeks after the accident.

259, 260. Two femora, the right fractured obliquely, and with comminution, through the upper half of its shaft. The several fragments have become firmly blended after some displacement of the lower half of the bone upwards behind the upper. The femur is shortened by about 5 cm. 3083

261. A right femur, fractured in a manner similar to the preceding, and united after corresponding displacement. The lower end of the upper fragment lies to the inner side of, and slightly in front of, the upper end of the lower, giving to the upper fragment an appearance as if adducted. 3103

262. Plaster cast of a right femur, fractured very obliquely downwards and inwards through the length of nearly the middle third of its shaft, the fragments of which have united after great displacement. The lower fragment has been displaced upwards upon the outer side of the upper for a distance of about 5 cm., and is rotated outwards so that the subcutaneous surface of the inner condyle looks almost forwards. The upper fragment is considerably adducted, in part, probably, in consequence of the displacement of the lower upon its outer side. The union of the fractured surfaces is very incomplete, these being united only in one situation posteriorly where they have lain in contact; and the rest of the union of the fragments is effected by two broad arches of new bone, one



passing between the anterior, and the other between the posterior separated parts of the fragments. The pointed upper end of the lower fragment appears also to have become united with the outer surface of the upper immediately below the great trochanter. The head of the bone shows advanced changes due to rheumatoid arthritis.

263. The lower two-thirds of a left femur, showing a recent comminuted fracture across the middle of its shaft. 3001

264. A left femur, fractured with comminution below the middle of its shaft. There is no evidence of repair of the fracture. The shaft is covered extensively with a layer of new bone resulting from chronic periostitis. 1327

The patient, who was under mercurial treatment for syphilis, died fourteen days after the injury. The other femur from the same patient is preserved in No. 566.

265. A vertical section of a left femur, repaired after a fracture close above its middle. The upper of the fragments is considerably flexed, and the lower has been drawn upwards behind it for nearly 5 cm. Their applied compact walls have become cancellous in texture, and the end of the upper fragment has been smoothly rounded by absorption. A triangular mass of dense bone occupies the angle behind the displaced parts. 3176

266. A right femur, united after a fracture passing obliquely downwards and forwards through the middle of its shaft. The lower half of the bone has been displaced upwards behind the upper for about 4 cm. 3094

267. A left femur, fractured nearly transversely below the middle of its shaft. The upper fragment is flexed and adducted; the lower fragment is rotated outwards and is drawn upwards on the outer and posterior aspect of the upper fragment so as to overlap it for 8 cm. The union is effected by a considerable mass of dense bone filling the interval between the overlapping fragments, and projecting posteriorly in several irregular pointed processes. 5959

268. A left femur, fractured with slight obliquity from behind downwards, through the junction of its middle and lower thirds. Union has occurred after slight displacement of the lower fragment upwards and behind the upper; the lower fragment has also been rotated slightly outwards, and its lower end displaced inwards, so that its union with the upper forms an obtuse angle. 5019

269. A right femur, fractured obliquely downwards and inwards through the junction of its two lower thirds. The fragments have become firmly united after slight displacement of the lower upwards upon the outer side of the upper. From the upper end of the lower fragment an irregular bony outgrowth projects for about 3 cm. upwards, backwards, and outwards.

270. Longitudinal sections of a right femur, the shaft of which has been fractured through the junction of its middle and lower thirds. Union has occurred after so much displacement of the lower fragment upwards behind its fellow that the two parts overlap for a distance of 10 cm. The lower of the fragments is tilted backwards, so that a long V-shaped interval, measuring 3 cm. across its base, exists between them; this interval is filled with cancellated osseous substance. Thorny outgrowths of new bone project from the callus, chiefly in the direction of the adductor muscles. 4248

271. A longitudinal section of the lower part of the shaft of a child's femur, transversely fractured and consolidated after impaction of the posterior border of the upper fragment within the cancellous tissue of the lower. There is considerable angular displacement of the fragments forwards; the angle behind them is filled with a mass of cancellated new bone.



272. The lower half of a left femur, recently fractured through the lower end of its shaft. The line of fracture passes in a somewhat curved direction downwards and inwards. 3062

273. The lower half of a right femur, fractured obliquely downwards and inwards through the length of the lower third of the shaft, portions of which have been entirely broken away. One large piece of the anterior wall of the shaft was driven into the medullary canal and impacted there. The upper fragment upon its outer aspect, and the pointed end of the lower, are extensively ulcerated; over the rest of their extent the surfaces of the fragments were increased in vascularity, as indicated by the increased size of the Haversian canals, or are obscured by a layer of extremely light and porous new bone. 3226

The fracture was compound and was followed by profuse suppuration. Amputation was performed six weeks after the accident.

274. A longitudinal section of the lower part of a femur, the shaft of which is transversely fractured about 2 cm. above the epiphysial cartilage, the cartilage itself having escaped injury. The lower fragment has been displaced and rotated backwards so as to form an obtuse angle with the upper. The surface of that part of the shaft which is preserved is covered with an adherent layer of new bone, except over the popliteal surface which was in process of separation as a sequestrum. The ends of the fragments are enveloped in callus, but no actual union exists between them. The cartilage has disappeared from the articular surface of the femur, and the cancellous bone is extensively exposed.

The patient, a boy, was admitted for necrosis of the femur and suppuration in the knee-joint, for which amputation was performed. The displacement of the lower fragment of the femur gave rise to an appearance of dislocation of the tibia backwards, although none existed. After amputation the femur and tibia were found almost completely ankylosed, the inflamed cancellous bone being separated only by a very thin layer of granulation-tissue; the posterior surface of the patella was carious.

#### FRACTURES IMPLICATING THE LOWER END OF THE FEMUR.

275. The lower extremity of a right femur, with the adjoining part of the shaft; the latter has been fractured a short distance above the condyles anteriorly in a somewhat V-shaped line and with slight comminution. From the lowest point of this fracture a second leads downwards between the condyles, passing in front vertically along the middle of the patellar surface so as to divide the lower end of the bone into two nearly equal parts. This fracture has been caused apparently by the forcible impaction of the wedge-shaped end of the shaft into the bone below; together the lines of fracture bear a close resemblance to the letter Y. Posteriorly considerable portions of the ends of the fragments are in process of separation after necrosis. The articular cartilage remains only in irregular isolated areas, the rest having been destroyed by ulceration. 3590

276. A left femur, in which a triple fracture has occurred. Near the junction of its middle and lower thirds the shaft has been obliquely fractured and repaired after considerable displacement of the lower fragment upwards in front of the upper. The lower fragment is rotated outwards for nearly a quarter of a circle. Further down the shaft has been broken irregularly across a short distance above the condyles in a manner similar to that shown in the preceding specimen, whilst the end of the femur has been cleft unequally by a fracture which passes vertically through the outer condyle into the knee-joint. All

these parts are inseparably blended after displacement backwards of the lower end of the bone, and especially of the inner fragment, the patellar surface being thus rendered uneven. The articular cartilage covering the several parts of the joint is intact.

It will be seen that although the condyles lie behind the fragment of the shaft immediately above them, they are nevertheless in the same line as the upper and larger of the fragments of the shaft.

3321

- 277.** The lower part of a right femur showing repair after a fracture of the extremity, which, passing from the intercondylar notch obliquely upwards and inwards, completely detached the internal condyle with a portion of the shaft above it from the rest of the bone. The internal condyle is displaced upwards for 1 cm., so that an abrupt groove in the articular surface indicates the line of the fracture. The upper end of the fracture is marked internally by a smooth elevation on the surface of the shaft and posteriorly by a rough ridge of bone. Immediately above the intercondylar notch a smooth oval opening has been left in the healing of the fracture.

2984

- 278.** The lower extremity of a right femur with the adjoining part of the shaft, the latter having been fractured transversely and with comminution a short distance above the condyles. From this fracture another extends vertically downwards into the intercondylar notch, completely separating the condyles from each other. A large isolated fragment of the anterior surface of the bone includes the upper part of the patellar surface. Posteriorly a fissure runs vertically upwards into the shaft. The only evidence of repair is the presence of small areas of new bone on the several fragments.

4258

- 279.** The bones of a left knee-joint, showing bony ankylosis of the joint in the extended position and a recent fracture of the lower extremity of the femur. Posteriorly the fracture crosses the bone immediately above the condyles, and in front it is at a rather lower level, passing through the upper part of the patellar surface. A large piece of the front of the outer condyle is wanting. There is no evidence of repair.

3158

The pre-existing ankylosis of the knee-joint, with, probably, atrophy of the bones, was doubtless the predisposing cause of the fracture.

- 280.** A left femur, fractured with great obliquity downwards and forwards through the lower third of its shaft, with such forcible displacement of the sharply-pointed end of the upper fragment downwards upon the lower that a deep groove has been cut through the anterior wall of the lower fragment as far as the patellar surface. From the lower end of the upper fragment a somewhat quadrilateral piece has been detached, and lies deeply impacted within the upper part of the lower main fragment, immediately above the upper end of the groove above mentioned. A small amount of callus has been thrown out on the surface of the upper fragment.

- 281.** A right femur, in which a fracture has occurred obliquely downwards and outwards through the length of almost the lower half of its shaft. The fracture terminates on the outer side immediately above the external condyle, in which the sharp point of the lower end of the upper fragment is firmly impacted. As the result of this impaction the outer condyle has been separated from the inner by a vertical fracture running through the patellar surface. The several parts have united after slight displacement of the lower main fragment, including the inner condyle, upwards.

1954

- 282.** The bones of a right knee-joint, in which a fracture has occurred through the outer condyle. Posteriorly the fracture starts exactly at the border of the articular surface, and extends in a regular line downwards and forwards through



the condyle, appearing inferiorly in a line with the front of the intercondylar notch. Some fibres of the anterior crucial ligament remain attached to the separated fragment of the condyle. 5685

The patient, a man aged 60, was run over and sustained a lacerated wound of the inner border of the right foot. Death occurred on the fifth day from acute septicæmia, the temperature rising to 107°·8. The injury of the knee was not suspected during life. (Mr. Heath's *Cases*, 1881, Vol. ii. p. 459.)

283. The knee-joints of a boy. In the right the anterior crucial ligament, along with part of the subjacent bone, has been torn from the head of the tibia. A vertical cleft passes across the articular surface of the inner tuberosity a short distance into the shaft. In the left knee-joint the anterior crucial ligament has been partly torn from its upper attachment, carrying with it the inner border of the outer condyle. A deep fissure passes directly upwards from the intercondylar notch, in front nearly to the upper border of the patellar surface, and behind through the wall of the shaft along the outer margin of the popliteal surface as far as the end of the portion of femur shown. 5244

The patient, 12 years of age, fell from a second-floor window on to a paved yard. In addition to the injuries just described, he sustained a compound fracture of the lower end of the humerus, and a fracture of the radius close above the wrist-joint. Some bruising was noticed about the knee-joints, but no crepitus could be felt on moving the bones. Both patellæ were uninjured, and the legs could be well flexed on the thigh without causing much pain. After death, which took place on the third day, the knee-joints were found to be filled with blood; and there was some extravasation about the abdominal and thoracic viscera. The injuries shown in the specimen most probably resulted from forcible and extreme flexion of the knee-joints.

284. The right knee-joint of a young person. The anterior crucial ligament with a scale of the subjacent bone has, with the exception of its posterior fibres, been wrenched from the head of the tibia. The external semilunar cartilage retains its connexion with the ligament and detached bone.

#### FRACTURES OF THE PATELLA.

These are divided into stellate, or those caused by direct violence (290), and transverse, or those resulting from muscular action (285). In the fracture by direct violence the prolongation of the supra-patellar tendon, which covers the patella, is not torn, and consequently the fragments are held well together and union takes place by bone (291). In those fractures caused by muscular action the fibrous expansion over the patella is torn at the time of the accident, and the fragments are widely separated, so that union by bone scarcely ever occurs, unless the fragments are brought into position by operation. The fragments usually become altered in shape, their angles being rounded off, and they are held together by a fibrous band varying in length and thickness with the success of the treatment adopted (286, 288).

285. A patella which has been transversely fractured above the middle, the parts of which are united through the medium of a band of fibrous tissue 1 cm. in length, passing between the posterior margins of the fractured surfaces. The fragments are tilted so that their fractured surfaces, which are smoothly rounded, are directed, the lower partly, the upper almost directly forwards. 3073

286. A vertical section of a patella, which has been transversely fractured above its middle. The fragments are so tilted that the anterior borders of the fractured surfaces are considerably further apart than the posterior; and the fractured surfaces themselves, looking almost directly forwards, are separated for a distance of 2 cm., but held together by a broad strap-like fibrous band, in which, near one margin, two small lenticular masses of new bone have been formed. 3073



287. A patella which has been fractured transversely near the lower border. The fragments, which are separated to the extent of 9 cm., are connected by a thin ligamentous band, in the centre of which an irregular transverse plate of new bone has been formed: the lower fragment also has been nearly doubled in size by the formation of osseous substance in the fibrous tissue above it, and a narrow line of new bone has in like manner been produced on the posterior border of the fractured surface of the upper fragment. 3073
288. A vertical section of a fractured patella in which firm union has occurred. The fracture is transverse and situated in the middle of the bone, and the fragments are held together by a layer of very dense fibrous tissue 6 mm. in thickness. 6787
289. A patella, together with the insertion of the quadriceps and the ligamentum patellæ. The bone has been fractured nearly transversely below the middle, and no union exists between the fragments. The fractured surfaces are covered with soft granulation-tissue, and a similar layer covers the aponeurosis on the front of the bone and also the synovial membrane preserved in the specimen. Two fissures extending through the cartilage of the upper fragment are filled with granulation-tissue. Bone has been deposited irregularly on the anterior surface of the lower fragment. 6428
- The patient, a man aged 31, sustained a simple fracture of the right patella and the lower third of the femur in June 1888. The fractures were treated by means of plaster of Paris at St. Bartholomew's Hospital. In the following November he was admitted to U. C. H. with extensive suppuration in the knee-joint and surrounding parts. The fragments of the patella were separated by  $2\frac{1}{2}$  inches, and in the skin between them was a sinus leading into the joint. Amputation was performed by Mr. Heath through the lower third of the thigh, the saw-cut passing through the consolidated fracture of the femur. The patient's recovery was delayed by suppuration in the stump and necrosis of the end of the femur. (Mr. Heath's *Case-books*, 1889, vol. ii. p. 140.)
290. A patella, together with the adjoining soft parts, the bone being broken into several fragments by direct violence. The fractured surfaces are coated with exudation, and the articular cartilage round the edge of one of the fragments has been removed by ulceration. 197
- The patient was a coachman, who, whilst driving, was thrown from his seat and fell upon his knee against the carriage-pole. Death resulted from suppuration in the knee-joint.
291. A patella broken into four pieces, probably by a fall on the knee. The fragments, none of which have been completely displaced from the rest, are united by bone along the contiguous parts of their borders. 3028
292. A patella, from the outer margin of which a strip has been detached by direct violence. The detached fragment is wanting. 198
293. A patella, from the outer edge of which a portion has been detached by a fracture. The fracture was comminuted. The larger fragment is united by bone but a smaller upper fragment is wanting. 3264
294. A left patella with the surrounding soft parts, the bone being separated into halves by a recent vertical fracture. At a distance of 4 cm. below the patella there is a triangular puncture in the skin, from which the track of the wound extends upwards and backwards to become continuous with the line of the fracture in the patella. A small mass of paint is adherent to one of the fractured surfaces. 7832
- F. F., a female, aged 28, whilst intoxicated, jumped from a third-floor window, and, after striking some iron railings, fell into the area below. The other injuries consisted of wounds of the scalp and thigh, a fracture of the left radius, and extensive laceration of the soft parts of the left leg. Amputation was performed by Mr. Horsley through the junction of the middle and lower thirds of the thigh. Death resulted from shock a few hours later. (Mr. Heath's *Case-books*, 1897, vol. i. p. 427.)

295. A cast of a knee, taken from a case in which the patella had recently been transversely fractured. The upper of the fragments has been withdrawn by the contraction of the extensors for a distance of 10 cm. from the lower; in the interval between them the prominent rounded borders of the patellar surface of the femur are distinctly recognizable. 2768
296. A cast of the same knee in the position of extreme flexion. A distance of 15 cm. intervenes between the fragments, and the lower end of the femur, uncovered by the patella, is traceable in almost all its parts. 2769
297. A cast of the front of a knee, in which a transverse fracture of the patella has united by fibrous tissue. The fragments are turned forwards and held together only at the posterior margin of the fractured surfaces, the bond of union between which seems to have been about 2 cm. long; the anterior margins are separated by a considerably greater distance. 5128
- 298, 299. Casts of the fronts of two knee-joints, taken from the same person. On the front of the right is a depression nearly 8 cm. in length, due to the separation of the fragments resulting from a transverse fracture of the patella. The fragments have probably been connected by a ligamentous band, no part of the femur being recognizable in the depressed interval noticed. In the left knee a similar condition exists, but the separation of the fragments is less marked. 4596

## FRACTURES OF THE BONES OF THE LEG.

Fractures of both bones of the leg may occur from direct violence at any part. Both bones are then usually broken nearly at the same level (307). When the fracture results from indirect violence, the tibia is usually broken near the junction of its lower and middle thirds, and the fibula at a point somewhat higher (6, 308, 311). The fracture of the tibia is most frequently oblique in a direction from behind forwards and downwards, so that the lower fragment is drawn upwards behind the upper, and the sharp point of the upper projects beneath the skin in front (6). The tibia may be fractured alone, usually at the place and in the direction above mentioned. The internal malleolus alone is sometimes broken off. Fracture of the fibula alone most frequently occurs within 5 cm. of its lower end (Pott's fracture), and is produced by a violent twist of the foot outwards. With this fracture there may be either rupture of the internal lateral ligament, or the tip of the internal malleolus may be torn off (318). The foot is in such cases displaced outwards (322). In some cases both malleoli may be broken off and displaced backwards with the foot (324).

300. The bones of the knee-joints, from the same person. In the right joint the head of the tibia is fractured from before back in the middle line to a depth of about 2.5 cm. The fracture runs between the right condylar surface and the attachment of the crucial ligaments, whilst behind it turns horizontally inwards in the groove on the back of the inner tuberosity. The fracture gapes widely, and a separate fissure runs across the inner condylar surface. 5481

The injury probably resulted from forcible wrenching of the leg inwards. In the left knee-joint a very similar fracture has been produced experimentally after death; it differs, however, in passing on the inner instead of the outer side of the attachment of the crucial ligaments.

301. The upper half of a left tibia, the upper extremity of which, together with a wedge-shaped portion of the shaft, has been detached by an oblique fracture



extending from immediately below the tuberosities behind to a point 6 cm. below the tubercle in front. Union has occurred after slight displacement of the lower fragment upwards and backwards. The outer tuberosity has in addition been fractured in a vertical direction. 2974

302. A left tibia, which has been fractured in a manner similar to the preceding, but repaired with greater deformity, the lower fragment having been considerably displaced behind the upper; the articular surface has not been involved. 216

303. A right tibia and fibula considerably shortened in consequence of the displacement resulting from an oblique fracture near the junction of their upper and middle thirds.

The lower fragment of the tibia has been drawn upwards and slightly outwards, and lies behind the upper, overlapped for a distance of about 7 cm. The fracture of the fibula is at a higher level than that of the tibia. The lower fragment of the fibula lies in front of the upper, overlapping it for about 5 cm., but maintains its normal relation to the lower fragment of the tibia; it is united to the middle of the anterior surface of the upper fragment, which is displaced outwards so that its lower end lies about 2 cm. external to its natural position, the fragments thus crossing each other.

304. The lower half of a right tibia, fractured obliquely near the middle of its shaft, the fragments of which are firmly held together by newly-formed external callus. The plane of fracture, contrary to what is usual, passes from before backwards and *downwards*; the lower of the fragments has, in consequence, been displaced by the action of the muscles upon the *front* of the upper so as to over-ride it. 3057

305. The bones of a left leg, fractured with slight obliquity a short distance below the middle, and at the same level. The fragments have become united after very slight displacement, the repair being strengthened by the union of the two bones themselves opposite the seat of injury.

The bones are very light, being much atrophied from old age, and a thin layer of new osseous tissue covers a considerable part of the shaft of the tibia. 3259

306. The bones of a left leg, fractured obliquely and with comminution, the tibia near its middle, the fibula at a point higher up. The fractures have been repaired after some displacement of the several fragments, which are united by new bone filling up the irregularities, and giving to the middle third of the tibia a long fusiform outline. 3077

307. The bones of a right leg, showing a recent comminuted fracture implicating the lower parts of their shafts nearly at the same level. Each of the bones is broken into several fragments, the result evidently of direct violence. In the tibia two fissures extend into the lower extremity of the bone, but do not reach the articular surface. In the fibula the lowest fragment is separated from immediately above the cartilage-covered surface. 5360

308. The bones of a right leg, fractured obliquely from without downwards and inwards through the lower third of their shafts; the line of fracture is continued accurately from the one to the other. The several fragments have become firmly united after some displacement of the lower upwards, and, as a result of the direction of the obliquity, outwards, the end of the upper portion of the tibia, still somewhat sharply pointed, overhanging the bone below on the inner aspect. The union of the parts has been strengthened by an osseous bond passing between the two bones at the seat of fracture. A fracture of the posterior part of the lower extremity of the tibia extending into the articular surface has repaired without deformity. 3181



- 309.** A left tibia and fibula fractured obliquely downwards and inwards, the former about 7 cm. from its lower end and the latter about the same distance below its upper, and united after upward and outward displacement of the lower fragments. The margin of the pointed end of the upper fragment of the tibia has undergone necrosis, and its separation is nearly completed; the surfaces of the bone in the neighbourhood are obscured by a thin layer of new bone; and some union between the fragments has been effected by osseous tissue which passes in bridges between them. The fragments of the fibula are held together by a thin layer of bone between their overlapping surfaces. 2631

The fracture of the tibia was compound.

- 310.** A left tibia and fibula which have been fractured with comminution across the junction of their middle and lower thirds. Between the fragments of the tibia no union has taken place: their ends are enlarged by an irregular deposit of new bone with an uneven nodulated surface formed upon them, in part, apparently, as a result of inflammation. The fracture of the fibula has been evenly repaired. The fibula presents a long uniform curve backwards and outwards throughout its length. 1411

The fracture of the tibia was compound, that of the fibula most probably simple.

- 311.** A right tibia and fibula fractured, probably by indirect violence; the tibia as in No. 308, and repaired after similar displacement. In the fibula the plane of fracture is directed downwards and backwards through the junction of its upper and middle thirds; union has taken place after displacement of the lower fragment upon the front of the upper. 214

- 312.** A left tibia and fibula, fractured about the junction of their middle and lower thirds, in a direction downwards and outwards; the lower fragments have united with the upper after slight displacement upwards and inwards. A bridge of new bone connects the tibia and fibula at the seat of fracture. 3257

- 313.** A vertical section of a right tibia, showing the remains of an oblique fracture which has been repaired after great displacement of the lower fragment. The upper end of this lies upon the front of the upper fragment, overriding it for about 2 cm., and the lower fragment is rotated outwards to such a degree that the articular surface for the fibula looks almost directly backwards. The lower fragment has also undergone an angular displacement laterally, the shaft of the bone presenting a long concavity on its outer aspect. 212

- 314.** The bones of a left leg, obliquely fractured through their shafts a short distance above the ankle. Union has occurred after angular displacement of the lower fragments outwards, more marked in the fibula than in the tibia. 3145

- 315.** The lower half of a right tibia, which has been repaired after separation of its articular end by a fracture passing obliquely from without downwards and inwards. The lower end has been sawn through vertically and shows impaction of the upper fragment into the lower, the latter being slightly displaced inwards. 3054

- 316.** The lower three-fourths of a right tibia and fibula each of which has sustained a comminuted fracture, the tibia in its lower third, the fibula through the middle of its shaft. In the tibia the fracture extends into the ankle-joint in such a way as to separate a large fragment including the anterior third of the articular surface. 2704

The fracture of the tibia was compound, and the limb was amputated.

- 317.** The lower half of a right tibia the inferior extremity of which has sustained an extensively comminuted fracture, the result of direct violence. A large number of small pieces have been separated, and numerous lines of fracture cross the articular surface. 3025

The fibula was also broken in its lower third.

318. The lower ends of a right tibia and fibula, together with the astragalus, os calcis, and navicular. The fibula has been obliquely fractured close above the ankle-joint, and the foot, with the lower fragment of the fibula, has been partially dislocated outwards after separation of the internal malleolus, which retains its connexion with the os calcis and lies beneath the inner end of the anterior border of the articular surface of the tibia, a series of conditions which constitutes one of the forms of Pott's fracture. There is slight fibrous union between the separated portions of the fibula. 194

The patient, an intemperate woman, met with the accident by slipping from the curbstone. The fracture was rendered compound by the broken end of the tibia being forced through the skin. Suppuration within the joint ensued, and the foot was amputated.

319. A left tibia and fibula, the latter being fractured about 7 cm. from its lower end, and the tibia across the base of the internal malleolus into the ankle-joint; the remaining part of the articular surface has also been detached by a fracture traversing the lower end of the shaft of the tibia in an upward and outward direction. The several fragments of the tibia have united with but a trace of deformity, and the articular surface, with the exception of a shallow furrow along the base of the inner malleolus, shows no sign of the injury. The lower fragment of the fibula is displaced inwards so as almost to touch the tibia, and is overlapped by the upper; this has probably been due to a displacement of the malleolus outwards. 3169

320. A left tibia and fibula firmly ankylosed at their lower ends, after a fracture of the latter bone a short distance above the ankle-joint. The tibia has been in no way injured, and no displacement of the fragments has occurred. The specimen is probably one of united Pott's fracture. 193

321. A left fibula united, with backward displacement of its lower fragment, after a fracture about 5 cm. above its lower end. 2980

322. Cast of a left foot and part of the leg, showing a form of displacement which accompanies fracture of the fibula near its lower end (Pott's fracture). The foot has been partially dislocated outwards, and everted, after rupture of the internal lateral ligament of the ankle-joint; the inner malleolus forms a marked prominence on the inner side. 4210

323. Cast of a right foot and leg, in which a similar injury has occurred. The outward displacement of the foot is somewhat less marked.

324. Cast of a left foot and adjoining part of the leg, illustrating a variety of displacement occurring after fracture of the lower end of the fibula and of the internal malleolus. The foot, with the lower fragment of the fibula and the detached internal malleolus (which retain their proper relation, both with the foot and with each other), has fallen backwards; the anterior border of the end of the tibia forms a somewhat abrupt swelling across the front of the ankle.

#### FRACTURES OF THE BONES OF THE FOOT.

Fractures of the bones of the foot usually result from severe direct violence, and are very commonly compound (325). The posterior extremity of the os calcis is occasionally detached by the forcible contraction of the calf muscles.

325. The bones of a left foot, showing fractures of the cuboid and first and fifth metatarsals. In the cuboid the fracture passes from near the postero-external angle obliquely forwards to the antero-internal angle, separating the bone into two parts. The fracture of the first metatarsal is oblique downwards and forwards through



the anterior half of the bone; that in the fifth metatarsal has a similar direction, but is immediately behind the head. 4205

The fractures of the metatarsal bones were compound, and the foot was amputated.

326. The metatarsal bones of a left foot; the middle three of them have been broken across near their distal extremities, the head of the fourth being wanting. 5361

The injury was caused by a cart-wheel passing over the foot.

327. The lower half of a right tibia and fibula, with the os calcis and astragalus. The bones of the leg are enlarged and irregular, partly through the displacement following a fracture near their lower ends, and partly through the long-continued inflammation attending the separation of a sequestrum from the tibia. The sequestrum, which includes the outer border of the articular end of the tibia, lies loosely between the lower ends of the two bones. The os calcis has been divided into an anterior and a posterior half by a fracture passing irregularly across it; the astragalus has probably also been fractured. All the parts are firmly united, and the several bones are ankylosed one to another. 196

The accident was caused by a fall from a height. A year after the fracture had united, dead bone could be felt from three sinuses which had formed about the ankle. Three years later the condition of the parts was unchanged, and as the health of the patient was failing, the limb was amputated.

## SERIES II.—DISEASES OF BONE.

### HYPERTROPHY OF BONE.

The specimens included under this heading are those in which there is more or less general enlargement of a bone, not evidently the result of inflammation. In the majority the structure of the bone is normal. Such a condition may be compensatory, as when an enlargement of the fibula results from a weakening of the tibia by injury or disease. It may also result from long-continued increase of vascularity, due to some inflammatory condition in the neighbourhood (328). Hypertrophy of the skull-bones is occasionally a consequence of atrophy of the subjacent part of the brain (330).

328. A sternum with the costal cartilages and ends of the ribs, all the ribs on the left side being enlarged to about three times the thickness of those on the right. The sections of the ribs show that the enlargement is the result of an increase in the amount of the cancellous bone, which in appearance exactly resembles that of the ribs on the opposite side, which are normal in size. The compact tissue is unaltered in thickness. 4067

From a patient who suffered from chronic empyema of the left side.

329. Transverse and longitudinal sections of one of the same ribs. 1188

330. The roof of a skull much thickened anteriorly by an overgrowth of its diploë (being 17 mm. in thickness over the frontal eminences), resulting probably from atrophy of the fore part of the brain.

It is firm and healthy in texture, and the tables are distinct and of natural thickness. The capacity of the cranial cavity is correspondingly diminished. 3251

331. The roof of a skull hypertrophied in a manner similar to the preceding, except on the right side, where the thickness of the bone is normal. 6029

From a patient who had for many years suffered from epilepsy, and subsequently became a criminal lunatic. There was atrophy of the left hemisphere of the cerebrum and the right half of the cerebellum.



## ATROPHY OF BONE.

In atrophy of bone one or more of the following conditions occur, not evidently as the result of inflammation :—Diminution in weight without marked change in bulk ; enlargement of the cancellous spaces by thinning and absorption of the laminæ of bone enclosing them ; in long bones, an enlargement of the medullary canal from absorption of the inner laminæ of compact tissue ; accumulation of fat in the spaces left by the disappearance of the osseous tissue. It will be noticed that, however extensive the atrophy of the bone may be, there is always an almost unaltered layer of compact tissue left beneath the periosteum.

Atrophy of bone may result from disuse ; the bone then retains its normal shape and size, but becomes light from thinning of the trabeculæ (332). Senile atrophy is best illustrated by the changes which occur in the lower jaw (340), skull (333, 334), and the neck of the femur. Atrophy from pressure is seen in the thinning of the skull-bones resulting from hydrocephalus (335). Atrophic changes also occur in the bones of paralysed limbs (345) and in certain diseases of the nervous system such as tabes and general paralysis. A more or less general weakening of the bony skeleton resulting in the occurrence of spontaneous fractures is also sometimes met with (50).

- 332.** A horizontal section of the bones of the tarsus and portions of those of the metatarsus, greatly atrophied from disuse. The spaces of the cancellous tissue are irregularly increased in size owing to a general thinning, and in parts to a complete disappearance of the osseous lamellæ which form them ; the fatty contents of the spaces have, for the most part, escaped. The bones themselves are of natural shape and size, and are bounded by a thin layer of compact tissue coated at parts with the articular cartilage, which is unaltered in appearance. 3632

The patient was a girl 11 years of age, in whom the limb was amputated for tuberculous disease of the knee-joint.

- 333.** The roof of a skull in which there is a symmetrical thinning of the central parts of both parietal bones. The shape of the interior is unaffected, the diminution in thickness being due to a disappearance of the outer table and diploë only. 4963

- 334.** The roof of a skull showing symmetrical thinning of the parietal bones similar to the preceding. The areas of thinning are however larger, and the whole calvaria is thinner than natural. 5839

- 335.** Part of the left half of the skull of an infant affected with hydrocephalus. The bones of the vault are uniformly thinned, except in the position of a network of ridges visible only on the inner surface and corresponding probably to the sulci of the distended hemispheres. In numerous places the bone is deficient, leaving rounded or oval openings closed by a thin membrane similar to that which closes the widely-open anterior fontanelle. 5805

- 336.** The calvaria of an infant, the subject of hydrocephalus and spina bifida. The skull presents changes similar to those seen in the preceding specimen. The perforations are most marked in the upper and posterior part of each parietal bone ; in these positions, and to a less extent elsewhere, the outer surface of the skull is marked by smooth bulgings.

337. A calvaria uniformly and greatly thinned, and at the same time expanded. In all parts, but especially over the frontal bone, the inner surface of the skull presents depressions and ridges corresponding to the gyri and sulci of the hemispheres. The sutures are normal. 6948

From a patient aged 17, in whom hydrocephalus resulted from a tumour of the cerebellum (see Medical Series).

338. The upper end of a fibula, showing effects due to senile atrophy. The size of the medullary cavity is increased by disappearance of the cancellous tissue and thinning of the compact wall of the bone. 5288

339. Part of the skull of an old person, in which, after total loss of the teeth, the alveolar portion of the upper jaw has become atrophied so as to be almost entirely wanting, the roof of the mouth being rendered nearly flat.

340. The lower jaw of a very aged subject. Its alveolar part has been entirely absorbed, and the jaw, of the body of which nothing above the line of the mylo-hyoid ridge remains, reduced to a slender horseshoe form. The angle of union between the body and ramus is obtuse.

341. A lower jaw, atrophied, but in a less degree than the preceding. The union of the body and ramus forms a very obtuse angle.

342. A sacrum unaltered in size, but remarkably lightened, and its interior made honeycomb-like by atrophy of the cancellous tissue. 1269  
Its weight is greatly reduced and its curve is very little marked.

343. Some of the bones of a foot from a case in which there was general atrophy of the whole skeleton. The cancellous tissue is very light from thinning of its lamellæ. The compact tissue has also undergone a diminution in thickness, forming a shell at some parts not thicker than writing-paper; over the tarsal bones it has in part disappeared, leaving the cancellous tissue exposed to view. The bones of the tarsus are ankylosed one to another as well as to those of the metatarsus. 2712

344. A rib, from the same patient, which has been fractured, and of which the fragments have united. 2713

345. A tibia and fibula, atrophied as the result of old-standing paralysis of the limb. The bones are very thin and slight, and for the greater part of their length the shafts have become almost cylindrical in shape, having lost all traces of the normal surfaces and borders. The upper extremity of the tibia is deformed, probably as the result of long-standing flexion of the knee.

From the dissecting-room.

## INFLAMMATION OF BONE.

Inflammation of bone differs in no material respect from inflammation of any other tissue, except that when recovery takes place and the inflammatory products are not completely absorbed, or in very chronic processes, the new tissue formed becomes developed into bone instead of fibrous tissue. Inflammation of bone may affect chiefly (1) the periosteum (346 *et seq.*), (2) the compact tissue (354 *et seq.*), (3) the cancellous tissue (364 *et seq.*), or (4) the medulla (371 *et seq.*); but it rarely, if ever, commences primarily in the compact tissue, and wherever it commences its effects are never limited to one tissue only.

The first series of specimens illustrates the most important effects produced by inflammation in the several parts of a bone as above enumerated.

The second series illustrates the varying conditions under which the different varieties of chronic inflammation of bone occur.

The third series illustrates the changes associated with the occurrence of Necrosis of bone and the varying conditions under which Necrosis results.

## I.—Specimens illustrating the Effects of Inflammation in the several parts of a Bone.

## 1. INFLAMMATION OF THE PERIOSTEUM.

*Simple Acute Inflammation* of the periosteum causes the membrane to become reddened and swollen, and a soft layer of cells accumulates beneath it, so that it strips more readily than natural from the compact tissue.

*Acute Suppuration* beneath the periosteum leads to more or less extensive stripping of the membrane from the bone (346), and almost always causes a varying degree of necrosis of the subjacent osseous tissue (347). In rare instances the periosteum itself sloughs.

*Osteoplastic or Ossific Periostitis* is characterized by the formation of new bone beneath the periosteum, and is met with in many different conditions attended with subacute or chronic inflammation of the membrane. The new osseous tissue may be distributed more or less diffusely over the affected bone (348); it may be limited to a circumscribed area with the production of a *node* (352); or, lastly, it may be deposited irregularly in the form of nodular masses or spicula, which are often spoken of as *osteophytes* (353). These new deposits of bone are at first soft and spongy (348); but ultimately, as recovery takes place, they become partly absorbed and smoothed down and dense in structure like the normal compact bone, from which they are then scarcely distinguishable (352).

**346.** The upper extremity of a right femur the periosteum of which has been extensively detached from the neck of the bone by acute suppuration beneath it. The separation is most extensive in front, where it extends from the anterior intertrochanteric line to the cartilage covering the head, the margin of which is eroded. On the inferior and posterior aspects of the neck only a narrow strip of the bone is denuded, whilst the upper aspect has altogether escaped. There is considerable swelling of the periosteum around the area over which it has been destroyed.

6515

From a boy aged 9 years, who developed obscure signs of inflammation in the right hip-joint two days after a fall which caused bruising of the right groin and scrotum. Four days later signs of pericarditis developed, and death occurred eleven days after the injury. The right hip-joint was full of pus, which had perforated the posterior part of the capsule. There were abscesses in the heart-muscle, lungs, kidneys, and beneath the periosteum of one of the ribs. The specimen illustrates acute infective periostitis of the neck of the femur followed by pyæmia. The heart is preserved in the Medical Series. (See Dr. Bastian's *Case-book*, 1889, Males, vol. i. p. 4.)



- 347.** A left tibia, in which a superficial strip of the compact wall along the middle of the crest, together with a layer of the wall on either side, has undergone necrosis, and is in process of separation. The necrosed part is surrounded by a broad, shallow, ulcerated groove, and on the inner side is deeply undermined. The surface of the living bone around is, except for a short distance above the necrosed area on the outer aspect, covered for the most part with a layer of new bone; in the situation noticed the wall of the tibia is superficially ulcerated, contrasting strongly with the unaltered surface of the dead portion. Near the inner edge of the tibia a second, much smaller, somewhat elliptical area has also become necrosed, and is completely undermined, remaining connected with the rest of the bone only by a narrow pedicle. 2912

The necrosis of the tibia followed separation of the periosteum by the extension of suppuration to it from phlegmonous erysipelas which attacked the leg. The patient, an old man, sank from exhaustion.

- 348.** A left femur divided longitudinally. The whole shaft is covered with an adherent layer of bone thrown out as the result of osteoplastic periostitis. The outer surface of the deposit is irregular and nodulated and in section it is readily distinguishable by its more open texture from the original compact tissue of the shaft. In many parts of the section the new deposit can be seen to consist of two layers—a deeper composed of delicate longitudinal lamellæ, and an outer of minutely cancellated texture. Parts of the shaft from which the shell of new bone has been removed show the surface to be fluted with fine vascular grooves.

- 349.** A right femur, the shaft of which is throughout its whole length considerably increased in circumference, and almost in a uniform degree, by an uneven and nodulated sheath of new bone, about 4 mm. thick, the changes having occurred as a result of periostitis. Along the linea aspera the new tissue is in greatest abundance and forms two high ridges, which, dividing inferiorly, bound the upper part of the popliteal surface; the nodules themselves have a smooth compact exterior. A transverse section shows the shaft itself to be little changed in size or structure; and in the superimposed bone two layers can be discerned—a deeper of open texture and having lamellæ set in a longitudinal direction, so as to form channels which run in the long axis of the shaft, and a more superficial layer of minutely cancellated texture, and corresponding with the plates and nodules laid upon the first. The Haversian canals of the compact tissue of the shaft are more numerous and larger than natural. A part of the shaft, from which the shell of new bone has been in part removed, shows the surface to be fluted with deep vascular grooves. 5000

- 350.** The long bones of a lion's hind limb, all of which show extensive deposits of new bone resulting from chronic periostitis. The new osseous tissue has a warty or coarsely nodulated surface and is minutely porous in texture. It is most abundant on the posterior surface of the femur, where it has accumulated to a thickness of about 1 cm. On the posterior surface of the tibia the new bone is marked with deep furrows, for the most part longitudinal, which have lodged the larger vessels of the periosteum. The uncovered surfaces of the bones are healthy and the bones themselves are not enlarged. The head of the femur is much depressed, and the margin of its articular surface lipped. 5137 3850

- 351.** The pelvis and femora of a lion in which over considerable parts of the pelvis and over almost the whole of the shafts of the femora a nodulated layer of new bone has been formed. The new osseous tissue closely resembles in appearance that described in the last specimen. In all parts the deposit is almost exactly symmetrical; the various articulations are normal.

**352.** A right tibia, upon the upper half of the shaft of which are two oval swellings or nodes, resulting from periostitis and inflammation of the superficial parts of the compact wall of the bone. One of these nodes, about 5 cm. in length, is seated on the outer surface near the line of the crest; the other, considerably larger, is on the posterior aspect; each of the swellings is longitudinally grooved, and has a porous surface, and upon the bone around a thin layer of similar substance has been formed.

The section shows the new bone to have become indistinguishably blended with the old, the compact tissue of which has, in many parts, become somewhat more porous than natural. 2988

The disease of the tibia resulted from syphilis.

**353.** The bones forming a left elbow-joint, on which, as the result of long-standing inflammation of the articulation, an irregular deposit of new bone has taken place beneath the periosteum. On the humerus and ulna the new osseous tissue forms pointed spicula (osteophytes). The cartilage has disappeared from all the articular surfaces and considerable destructive inflammation has occurred in the subjacent bone. 3120

The deposit of new bone has resulted from osteoplastic periostitis secondary to the joint disease.

## 2. INFLAMMATION OF COMPACT BONE.

*Acute Inflammation* of compact bone is not met with as a primary affection, but the extension of inflammation into the osseous tissue from the periosteum or medulla is one element in the production of necrosis as the result of suppuration in either of these structures.

*Rarefactive Osteitis* is a common form of inflammation, usually subacute or chronic, of the compact tissue. The solid bone disappears before the exudation into the Haversian canals, which become enlarged so that to the naked eye they appear increased in size and number, and thus the bone becomes more porous and lighter than natural (355). By an extension of this process parts of the bone may be completely destroyed superficially and replaced by granulation-tissue; the condition is then known as ulceration or caries of compact bone (357).

*Osteoplastic Osteitis (Sclerosis of bone, Osteosclerosis)* is another common form of very long-standing inflammation of compact bone. New osseous tissue is deposited interstitially on the walls of the Haversian canals, which become diminished in size or obliterated so that the whole affected part of the bone becomes of unnatural density and hardness (358). The diminished vascularity of the bone thus produced is occasionally a factor in the causation of necrosis. In cases of recovery from rarefactive osteitis the process becomes osteoplastic, and new bone is thrown out in the dilated Haversian canals until the bone returns to its normal density or even beyond it.

"Expansion of bone" is a not uncommon result of chronic inflammation of the compact tissue. In one form, such as that which results from the growth of a central tumour, absorption of the inner layers of the compact tissue (rarefactive osteitis) proceeds simultaneously with a deposition of bone beneath the periosteum (osteoplastic periostitis). As a rule in such cases the deposition of bone externally fails to keep pace with the absorption internally, and thus the bone becomes progressively thinned and eventually in parts completely absorbed (359). In the other form, as the result of rarefying osteitis, the whole thickness of the compact tissue becomes converted into thin widely separated lamellæ, so that a great increase in bulk in the affected portion of bone occurs (360, 362). Under no circumstances is the osseous tissue actually expanded according to the ordinary sense of the word, that is to say mechanically stretched.



**354.** A longitudinal section of the lower part of a right femur which has been extensively affected by chronic inflammation. The compact tissue especially of the anterior wall is rendered porous by longitudinally disposed spaces in its substance which are separated by thin trabeculae. The openings of the Haversian canals on the inner surface of the compact tissue are much larger than natural. These changes have resulted from rarefactive osteitis. The outer surface of the shaft is covered by a layer of newly formed bone, and masses of very delicate porous bone project in many parts into the medullary canal. 2935

**355.** The lower half of a left femur fractured with comminution. The greater part of the wall of its shaft is thinned, longitudinally furrowed, pitted, and in places perforated. The bone is thus rendered light and open in texture like the interior of a spongy bone. A small amount of new osseous tissue has been thrown out on the surface of the shaft beyond the limits of the disease. 245

The only history attached to the specimen is that the fracture occurred whilst the patient was turning in bed.

**356.** A horizontal section of the shaft of a femur which is thickened by a deposit of bone on its inner and outer surfaces and altered in texture as the result of chronic inflammation. The compact bone has become much less dense than natural by the enlargement of its Haversian canals, and is indistinguishable from the new bone deposited upon it. Large irregular spaces exist in the coarsely cancellated bone around the medullary cavity. 2939

**357.** The metatarsal bone with the phalanges of a great toe, the surface of the former being very uneven and rough in consequence of advancing ulceration; the spaces of its exposed cancellous tissue have been enlarged and made to open irregularly into one another by the inward spread of the ulcerative process. The surfaces of the metatarso-phalangeal articulation have been destroyed, and the cancellous tissue of the ends of the bones laid bare. The epiphysis at the base of the metatarsal bone has not been involved in the disease. 2965

**358.** A longitudinal section of the upper part of a right femur. The compact tissue has in parts become almost ivory-like in density as the result of osteoplastic osteitis. The cancellous tissue of the upper extremity is also much denser than natural, the cancellous spaces being largely filled with new bone. The surface of the shaft is covered with a layer of newly formed very dense osseous tissue indistinguishable from the sclerosed shaft beneath. The medullary canal is reduced in size by a deposit of similar dense bone within it. 2968

**359.** The skeleton of the fore limb of a fox. The humerus and radius, and in a less marked degree the ulna, have been so widely "expanded" and so extensively hollowed as to bear some resemblance to a dried knuckle of inflated intestine. The walls of the bones are in parts membranous, formed only by the periosteum, and their interior presents scarcely a trace of any cancellous structure. Several of the other long bones were similarly affected. 3221

**360.** A right hip-bone the iliac fossa of which presents an irregular deposit of new bone indicating the position of a chronic abscess which occupied it. The ilium is so expanded by inflammation of its substance that its inner surface is almost flat. The laminae which represent its compact wall are distinct and separated, their cut edges lying in parallel lines conformably with the surface, and the cancellous tissue is very wide and honeycomb-like. An oval portion of the bottom of the acetabulum has been removed by absorption; the edges of the aperture are smoothly rounded, and the inner surface of the surrounding bone is in places coated with a thin layer of new bone. 3186



361. A left tibia in vertical section. At about the middle of its length the bone is slightly expanded for a distance of 8 cm., and presents an elongated cavity in its interior which is shut off from the medullary canal at either end by a deposit of new bone. The cavity is lined by a delicate osseous deposit and the compact tissue of the shaft which surrounds the cavity is thickened, especially posteriorly. The superficial surface of the bone in the expanded portion is covered by a nearly smooth deposit of new bone, and the rest of the shaft, especially near its lower extremity, presents numerous irregular deposits on its surface.

There is no history to the specimen.

362. The lower half of one of the long bones, from some animal, greatly increased in size by inflammatory expansion of its textures. The spaces of the cancellous tissue are much enlarged, and the compact tissue is represented by widely separated concentric laminae connected by delicate spicula. At the upper end of the specimen the bone is unaltered in shape or size. The whole bone is lighter than natural. 2672

363. A longitudinal section of the right femur of a young subject, its lower end considerably enlarged in consequence of inflammation; the cancellous tissue in this situation is very open, its lamellae being reduced to a collection of branching rods, between which, at some parts, large spaces exist. The laminae which represent the compact wall of the shaft are also separated from one another, giving rise to long longitudinal clefts on the surface of the section. The lower epiphysis has in parts become continuous with the shaft in consequence of the inflammatory process, whilst the upper, which is naturally the first to unite, remains still separate. 5157

The premature union of the lower epiphysis would have seriously interfered with the subsequent growth of the limb.

### 3. INFLAMMATION OF CANCELLOUS BONE.

*Acute Inflammation* of cancellous bone rarely occurs primarily. When suppuration takes place in the medullary tissue necrosis of the osseous substance is likely to occur.

*Rarefactive Osteitis* is by far the most important variety of inflammation met with in cancellous bone. The normal contents of the cancellous spaces are replaced by granulation-tissue, and the osseous trabeculae are thinned and finally in part destroyed, so that the tissue becomes much more porous and lighter than natural (364). By an extension of the same process a part of the cancellous tissue may be entirely destroyed and its place occupied by a mass of soft granulation-tissue; the condition is then spoken of as caries of cancellous bone (*central or internal caries*). As a further stage of rarefying osteitis it frequently happens that softening of the granulation-tissue takes place with the formation of a *chronic abscess*. This and other varieties of caries are fully illustrated by the specimens of tubercle of bone (see p. 98). From whatever cause resulting a chronic abscess of the cancellous tissue is surrounded by sclerosis varying much in extent and degree (369), and the affected part of the bone is most commonly enlarged by the formation of new bone beneath the periosteum (364). The cavity containing the pus is lined with granulation-tissue, and may contain small fragments of necrosed cancellous bone. The pus may gradually find its way to the surface, leaving a sinus passing into the cavity (369), or it may burst into a joint (366). It not uncommonly happens that, in the process of extension of caries of cancellous bone, a more or less extensive portion of the osseous tissue is so completely isolated from its vascular supply that it dies and is separated as a sequestrum; the process is then called *necrotic caries* (365). Under these circum-

stances the sequestrum is usually very spongy, as the result of the rarefying osteitis which preceded its death.

*Osteoplastic Osteitis* of cancellous bone occurs under conditions similar to those leading to sclerosis of compact bone. New bone is deposited on the trabeculae so that the cancellous spaces become gradually diminished in size, and the tissue becomes denser than usual so as more or less closely to resemble normal compact bone (358). Osteoplastic osteitis always occurs when healing follows the process of rarefying osteitis, and thus the enlarged spaces of the rarefied bone become more or less filled up and the surface rendered dense and smooth (368).

**364.** A left os calcis extensively excavated on its outer side as the result of caries. The rarefactive osteitis is evidenced by the thinning of the lamellae and the irregular enlargement of the spaces of the cancellous tissue around the excavation. A portion of the spongy tissue in the posterior part of the cavity is darker in colour than the rest and extensively separated from its attachments, and by the extension of the disease would shortly have been separated as a sequestrum. The surface of the bone is everywhere covered with a layer of imbricated plates and nodules of new bone (osteophytes); the articular surfaces are healthy with the exception of the anterior and outer border of the posterior surface for the astragalus, which is undermined and in part destroyed by ulceration. 2433

The destructive inflammation of the cancellous tissue was doubtless the result of tuberculous disease. The bone was trephined.

**365.** The upper portion of a left femur the head and neck of which had been removed by operation some years previously. The surface of the bone to which the neck was originally attached is occupied by an elliptical opening 1.5 cm. in its longer diameter. This leads into a central cavity which extends upwards into the great trochanter. The cavity is bounded by rarefied cancellous bone and contained six spongy sequestra, the largest of which is still *in situ*. The edges of the aperture are smooth and rounded. The compact tissue of the sawn surface of the shaft is much rarefied and numerous osteophytes project from the surface of the trochanter.

The piece of bone was removed by Mr. Marshall from a man, aged 40, in whom suppuration in the region of the hip occurred after excision of the head and neck of the femur.

**366.** The outer half of a left tibia, almost universally enlarged and converted into a uniform mass of cancellated tissue, contained within a compact wall about 2 mm. in thickness, by long-continued osteitis. In each of its ends there is the cavity of a chronic abscess. That within the upper is about 1.5 cm. in diameter, distinctly circumscribed, and lined with a soft, smooth, membrane-like layer of granulation-tissue. Extending forwards from this cavity are at least three sinuses, none of which reaches the external surface; the aperture of the largest sinus is about 3 mm. in diameter, and, like the others, it has smooth bevelled edges. In the plane of section, also, one of the sinuses, lined with similar false membrane and winding in course, has, for a part of its extent, been exposed. The lower abscess presents similar characters; from its upper part a track leads into the surrounding bone, and below, the abscess seems to have communicated by an irregular sinus with the ankle-joint. 5206

**367.** The inner half of the same tibia, macerated. The cavity within its upper end leads to the surface by a wide irregular aperture in the front of the bone, and by a smaller aperture situated posteriorly. On the inner surface, a short distance above the malleolus, there is a deep sulcus about 5 cm. in length, running with slight obliquity in the axis of the bone, the remains of an incision made some time previously into it. The bone is throughout light and very friable.

The parts were removed by amputation through the knee, after which the patient did well. (Sir J. Erichsen's *Case-book*, Emma King, Jan. 1866.)



368. A right astragalus and os calcis, in both of which extensive caries has occurred. The head of the astragalus has been completely destroyed and the resulting surface, which had been deeply excavated by ulceration, shows definite evidence of healing; the surface has become smooth and the open cancellous spaces have been extensively filled up by a deposit of new bone on the trabeculæ. The outer part of the cuboid surface of the os calcis is occupied by a hollow large enough to admit the end of a finger; the cancellous bone exposed in the wall of this cavity is rough and more open than natural, and contrasts in these respects with the healing surface on the astragalus. The narrow strip of the cuboid articular surface which remains is superficially ulcerated. 3115

The changes in the bones resulted from tuberculous disease.

369. A tibia of a quadruped, longitudinally bisected through an abscess in its upper end, and a sinus leading from it to the anterior surface of the bone. The cavity of the abscess, oval in shape, flattened conformably with the surface, and measuring about 4.5 cm. in length, lies close beneath the compact wall of the shaft, the deeper part of which has been removed by absorption. Cancellated new bone of considerable density fills the medullary space behind and below the abscess, and similar osseous substance has been formed upon the surface of the tibia for 3 cm. around the external opening of the sinus. The interior of the cavity is lined with a granulated layer of minutely reticulated osseous tissue; some of this is of very recent formation, and has evidently been produced by ossification of the granulations formed on the sides of the healing cavity, which communicates freely with the exterior. The wall of the sinus is lined with a somewhat similar layer. 3060

370. The lower half of a right femur, enlarged, and its surface uneven and undulating in consequence of inflammation. On its outer aspect, 11 cm. from the lower end, is a smooth-edged, almost circular aperture, about 7 mm. in diameter, the opening of a short passage by which an abscess within the bone has opened externally. The spaces of the cancellous tissue are larger than natural, but the tissue itself is very firm, its rods and lamellæ being for the most part thickened by the formation of new bone upon them; the wall of the shaft is thinner than natural. 3256

#### 4. INFLAMMATION OF THE MEDULLA.

*Acute Suppuration (Acute Suppurative Osteomyelitis)* may occur as a primary infection (see Acute Necrosis, p. 90) or may follow an infected wound exposing the medulla. The normal medullary tissue disappears before the inflammatory exudation, until the interior of the bone may become occupied by pus (371). Necrosis is an almost invariable result, and, according to the extent and intensity of the inflammation, may involve the whole thickness of the compact bone or only its inner layers (372).

*Chronic Inflammation* of the medulla may manifest itself in the same forms as those seen in the medullary tissue of cancellous bone. In that corresponding to rarefactive inflammation the normal medullary tissue is replaced by granulation-tissue, which may invade the surrounding bone, producing caries or necrosis (373). Osteoplastic inflammation of the medulla is characterized by the formation of new osseous tissue on the inner surface of the compact bone, so that the medullary cavity is encroached upon and may become entirely occluded (374). It is a common



result of various forms of chronic inflammation of the long bones, and is always associated with more or less chronic osteitis and periostitis (374).

**371.** A right humerus in vertical section together with the upper ends of the forearm bones. The head of the humerus is completely separated from the shaft, and the cartilaginous surface is extensively eroded in the lower part as the result of suppuration in the shoulder-joint. Below the head are several loose pieces of bone detached from the shaft. The outer surface of the shaft is covered with a thin layer of new bone which is most abundant at the two extremities, the deposit at the upper end forming a thick collar around the shaft. The medullary canal in its present condition shows an almost complete absence of medullary tissue; in the recent state it was occupied throughout its entire length by pus. The lower extremity is partly separated from the shaft, and a sinus opening on the surface of the skin leads into the interior of the bone in this situation. The cartilaginous surfaces of all the bones entering into the elbow-joint are extensively eroded as the result of suppuration in the joint.

The femur from the same case is preserved in No. 456.

**372.** A long sequestrum removed from the femur after amputation of the thigh. At its lower end the sequestrum involves the whole thickness of the bone in parts of its circumference, and the marks of the saw on the divided surface are still evident. Above its lower extremity the sequestrum has a long tapering shape and involves only the deeper parts of the shaft. The upper end of the sequestrum has a very irregular outline, and the whole of its outer surface is irregularly grooved and pitted as the result of the process of ulceration by which it was separated from the living bone around.

The necrosis resulted from septic inflammation of the medulla after the amputation.

**373.** Vertical section of a middle finger removed by amputation. Almost the whole length of the first phalanx is invaded by softened granulation-tissue, which probably beginning as a central deposit in the medulla, spread into and destroyed the wall of the shaft, causing a considerable fusiform swelling. The epiphysis at the base of the phalanx has completely escaped, and although the disease has spread into the head of the bone the cartilage covering it appears to be normal.

From a girl, 5 years of age, in whom there was a strong family history of phthisis. The disease of the finger, which resulted from tuberculous deposit in the phalanx, was of three years' duration. A sinus was present on the outer side of the finger, and the lymphatic gland over the internal condyle was enlarged.

**374.** A right tibia and fibula. The shaft of the tibia is, throughout its extent, enlarged by a deposition of new bone upon it, which has been rendered very dense by its transformation into compact tissue, and with which the proper wall of the shaft is intimately continuous; the medullary canal is almost obliterated by firm cancellated osseous tissue. A small amount of new bone has been deposited on the surface of the fibula.

## II.—Specimens illustrating the Conditions in which the different varieties of Chronic Inflammation of Bone occur.

### 1. OSTEOPLASTIC INFLAMMATION.

The following series of specimens illustrates the chief conditions in which osteoplastic inflammation of bone occurs, whether affecting the periosteum (p. 66), the medulla (p. 72), or the osseous tissue (p. 68). From a practical standpoint these varieties of osteoplastic inflammation can only be regarded collectively, as even the most simple cause rarely affects the periosteum or osseous tissue or medulla solely, so that, for instance, chronic osteoplastic periostitis and chronic osteitis are almost invariably met with in association with each other.

*General causes.* Syphilis is the most common general disease causing osteoplastic inflammation of bone, and the syphilitic affections of the bones will be considered in detail in a special series (p. 116). The periosteum may be chiefly affected (375), and whilst new bone is deposited superficially a certain degree of rarefaction of the underlying compact tissue may occur (376). In other cases the whole substance of the bone becomes sclerosed and the medullary canal more or less completely obliterated (378).

*Local causes.* A limited degree of osteoplastic inflammation affecting chiefly the periosteum may occur as a result of an *injury* to the bone. *Central disease* of a bone, such as chronic abscess or tuberculous caries, usually causes a deposition of new bone beneath the periosteum and often sclerosis of the osseous tissue (380). Associated with any form of *necrosis*, new bone is not only deposited by the periosteum to form the involucrum (p. 79), but often forms widely over the surrounding living bone (379), and should the sequestrum remain long *in situ* the living osseous tissue in the neighbourhood may become greatly sclerosed (405). In association with various chronic forms of *articular disease* new bone is commonly deposited on the surface of the adjacent bones, often in the form of irregular osteophytes (381, 382). Lastly, a varying amount of new bone is frequently formed beneath the periosteum as the result of *disease of the overlying soft parts* (385); this condition is best illustrated by the deposit of new bone which may occur on the tibia beneath a chronic ulcer of the leg (386, 387).

**375.** A left femur the greater part of the shaft of which is covered with a layer of new bone formed as the result of chronic inflammation of the periosteum. In many parts the newly formed osseous tissue presents a longitudinally furrowed surface but, especially on the outer surface of the shaft where the deposit is thickest, the new bone has an uneven and trabeculated surface and the plates themselves have a smooth compact exterior. Both extremities of the bone are normal. 3879

There is no history to the specimen, but the chronic periostitis probably resulted from syphilis.

**376, 377.** The two femora from the same subject, the shafts of which are uniformly enlarged by an ensheathing layer of new bone formed upon them as the result of periostitis. A section through the middle of the left femur shows that the compact bone itself is also altered by inflammation, the superficial layers more especially being rarefied and indistinguishable from the new bone deposited upon them. The superficial layers of the new periosteal bone are dense and compact. 3327

**378.** A right tibia the middle part of the shaft of which presents a long fusiform enlargement in consequence of the deposition upon it of new osseous tissue which has become uniformly compact so as almost perfectly to resemble the surface of the healthy parts of the shaft. A transverse section through the middle of the



bone shows that the medullary canal has become almost obliterated by dense slightly cancellated osseous tissue. 1336

**379.** A right tibia and fibula from a young subject, showing an early stage of the formation of new bone upon their surfaces. The tibia and fibula have both been fractured, the former across the middle of its shaft, the latter in two places, at the junctions of its several thirds. The fracture of the tibia and the upper of the fractures of the fibula were compound. At the sites of the compound fractures necrosis of varying portions of the ends of the fragments has occurred. The necrosed parts, unaltered, and with their fractured edges still sharply toothed, are, for the most part, marked off from the rest of the bone by shallow ulcerated grooves, beyond which the surface is obscured by a layer of new bone, thickest in the immediate vicinity of the furrows, and becoming thinner as traced further away, till it ceases to be recognizable, and is replaced by the unchanged surface of the shaft. It will be noticed that the new bone nowhere reaches the groove of demarcation between the living and dead portions, and that the intervening surface of the bone is altered in character, being marked by longitudinal grooves and an increase in the number and size of the Haversian canals; a few points of newly-formed osseous substance also are scattered over it: this condition has resulted from separation of the periosteum from the bone over this area. The new osseous tissue, of a minutely porous texture, is delicately grooved in a longitudinal direction throughout its extent, an appearance which becomes more marked as the layer increases in thickness, and is due to the longitudinal course of the periosteal vessels; the great vascularity of the new bone is also evident, every groove and pore having in the recent state transmitted a vessel enveloped with osteoplastic tissue. 3279

**380.** The lower half of a femur, in the medullary canal of which an abscess has at some time formed. The cavity of the abscess is about 10 cm. in length and reaches downwards to within 3 cm. of the condyles; its interior is lined with a layer of bone, having an uneven granulated surface, and produced apparently in the granulation-tissue growing from the sides of the space. The medullary canal above the cavity, for a distance of about 4 cm., is filled with dense osseous substance; and from the middle of the cavity itself a sinus, about 8 mm. in diameter, leads through the thickened posterior wall of the bone.

The size of the femur is increased by irregular deposition of new bone upon it; the new bone is very dense and indistinguishably blended with the proper tissue of the shaft. 3118

**381.** The lower ends of a left tibia and fibula, upon which a thick layer of new bone, formed in variously shaped, closely-packed nodules so as to give to the surface a tessellated appearance, has been formed in consequence of the long-continued inflammation set up in the parts around by disease of the ankle-joint. The cancellous tissue beneath the articular surfaces is uniformly exposed by ulceration, and a small necrosed portion within the internal malleolus has been almost isolated by the spread of ulceration round it. 2640

**382.** The metatarsal bone and first phalanx of a horse. Their adjacent ends are enveloped in an irregular globular mass of bone formed upon them, as a result of the inflammation attending disease of the metatarso-phalangeal articulation, which is itself ankylosed; a mass of similar bone, in part continuous with it, is attached to the sesamoid bones, and has almost surrounded the flexor tendons. 3870

**383.** The tibia and fibula of a pig, together with the bones of the foot. Upon the lower parts of the tibia and fibula, and the bones of the tarsus, a great abundance of light porous new bone has been formed, probably in consequence of articular disease. The osseous tissue is arranged in coral-like and foliated masses springing from the several bones, its parts being in many places continuous.



The articular surfaces of the bones forming the ankle-joint have been extensively destroyed. 3063

384. The phalanges of a horse's foot, the first and third greatly misshapen by the formation upon their sides of large coral-like masses of new bone. The joints are healthy.

385. A left clavicle in which, owing to malignant disease of the neighbouring parts, the compact wall is riddled over a large extent with irregular apertures, either ulcerated or formed in consequence of the spreading of the malignant growth into the bone. Upon its ends, and over a small area of its most prominent part, a layer of new bone, 1 cm. thick, has been formed; the channels of the new bone run with precise parallelism in a direction vertical to the surface. 3271

386. A left tibia and fibula. On the inner aspect of the tibia, near the junction of its middle and lower thirds, is a circumscribed, almost circular, deposit of bone, about as large as a shilling and raised for 4 mm. above the surrounding surface. It is cancellated in structure, and has probably been formed in the base of an ulcer of the integument situated over this part of the tibia. Upon the neighbouring surface, also, new bone has been deposited, which, on the outer aspect, has become as dense as the wall of the shaft itself: the corresponding portion of the fibula presents somewhat similar changes; and both the bones are very dense and increased in weight in consequence of long-continued inflammation of their substance. 3188

387. The lower part of a tibia in antero-posterior section with the overlying soft parts. The skin presents a large irregular chronic ulcer, and on the surface of the tibia corresponding to the base of the ulcer a considerable deposit of new bone has been formed. The new bone exactly resembles in texture that of the neighbouring compact tissue of the shaft, which is distinctly more porous than natural. 5736

From a woman, aged 63, in whom the ulcer, which followed an injury to the leg, was of six years' duration. The ulcer failed to heal under ordinary treatment, and amputation was performed by Mr. Heath in the upper third of the leg. (Mr. Heath's *Case-books*, 1882, vol. ii. p. 277.)

## 2. RAREFACTIVE INFLAMMATION.

The following series of specimens illustrates the chief conditions in which rarefactive inflammation of bone occurs, whether affecting the compact tissue (p. 68) or the cancellous tissue (p. 70).

*Tuberculous disease* is the most common cause of rarefactive osteitis, and is illustrated by a special series (p. 98). It affects most commonly the cancellous tissue, where it usually proceeds to more or less loss of substance (caries); less commonly the compact tissue is affected superficially (388).

*Syphilis* produces as one of its effects on the bones rarefactive osteitis, more especially of the surface of the compact tissue (superficial caries) (389 and special series, p. 116).

*Simple inflammation* of the osseous tissue may lead to considerable rarefaction, sometimes even proceeding to actual loss of substance. This is most often seen when the inflammation of the bone is consequent upon suppuration around it (390, 391).

*Articular disease* when attended with suppuration and the separation of the articular cartilage leads often to rarefactive inflammation of the subjacent bone. This is particularly marked in tuberculous joint-disease and is also a result of acute suppurative arthritis (393, 394, 395).

The destruction of osseous tissue resulting from its invasion by a *tumour* is produced by a process allied to rarefactive osteitis, the bone becoming eroded and replaced by the elements of the tumour itself (385).

- 388.** The bones of a right forearm. The outer border of the ulna, a short distance above its middle, is deeply notched, and its posterior surface presents several depressed oval areas, as a result of ulceration; at four points the shaft is perforated and in others it is deeply pitted. The ulcerated surface has, for the most part, smoothly healed and is covered with a thin layer of compact bone. The middle part of the radius is enlarged by a layer of reticulated osseous tissue, in which, posteriorly, is a shallow circular pit, probably the remains of a superficial ulcer. 242

From a case under the care of Dr. A. Todd Thomson. The patient was of a "scrofulous habit," and had disease of the wrist, which extended upwards to the elbow. Abscesses continued to form and to open in the arm and forearm during several years. The patient put himself under the care of a shampooer, who broke the arm above the elbow by the violence of his treatment. The fracture united, although at this time the sore extended from the shoulder to the fingers. The humerus was broken again some time afterwards in a different place whilst the patient was opening a garden-gate. An attempt was made to save the limb, but amputation was necessary.

- 389.** A calvaria, about 5 cm. from the posterior superior angle of the left parietal bone of which is a circular ulcerated aperture nearly 2 cm. in diameter, the result of syphilitic caries. The surfaces around the opening, especially the inner, where the disease has spread over an area nearly 8 cm. in diameter, have been made rough and uneven by ulceration. A second, less regular but considerably larger opening exists in the same bone near its lower part, and the tables in its neighbourhood are similarly ulcerated, suppuration having occurred both beneath the periosteum and between the dura mater and the parietal bone. Scarcely a trace of new osseous substance has been formed on the outer surface; but on the inner table, in the neighbourhood of the caries, there are streaks and patches of very dense new bone composed of curling and intersecting ridges of hard osseous substance, by the union of which an almost uniform layer has in parts been formed; in some spots the new bone fills the natural grooves for the meningeal vessels. 3261

- 390.** The metacarpal bone and phalanges of a thumb. The palmar surface of the base of the first phalanx and, to a less extent, the adjacent part of the metacarpal bone are irregularly excavated by ulceration. The cartilage on the phalanx is undermined, but the joint appears to have been healthy. 2942

From a patient who suffered from whitlow followed by sloughing of the flexor tendons.

- 391.** The phalanges of a finger. The second and third phalanges have been converted into thin imperfect shells, enclosing a wide lattice-like osseous structure, in consequence of destruction of their tissue by ulceration. The articular surfaces show no signs of disease. 2940

The disease of the bone was probably secondary to whitlow.

- 392.** Part of a femur, from an amputation-stump. A narrow ring, including the entire thickness of the sawn bone, is necrosed, the superficial limit of the necrosis being accurately defined by a scalloped ulcerated groove. The deeper part of the shaft above this groove has, for a distance not definable, also become necrosed. Anteriorly the sequestrum includes nearly the entire thickness of the wall, a thin surface-layer only having escaped, which has been removed by ulceration. Ulceration is in progress, also, above this, where the surface of the shaft is irregularly and extensively pitted and furrowed, the limit between the ulcerating parts and those separating as a sequestrum being as yet indeterminable. Posteriorly a layer of new bone has been laid upon the living part of the shaft. 2971

The necrosis resulted from the extension of suppuration from the soft parts to the medulla and the ulceration of the living bone higher up from inflammation of the periosteum and compact tissue.



393. The bones of a right elbow-joint, in which, as the result of acute suppurative arthritis, the articular cartilage and subjacent bone have disappeared, leaving the spongy texture of their ends open to view. The loss of substance is most marked in the articular surface of the ulna. The adjoining surfaces of the bones are covered with thickly-set projecting nodules of new bone. 2930

The limb was removed by amputation.

394. The lower ends of a right tibia and fibula, together with the astragalus. By the ulceration of the articular cartilage and the layer of compact bone closing the cancellous tissue of those parts of the bones which form the ankle-joint, the open cancellous tissue has been uniformly exposed; the adjoining surfaces and borders of the several bones are irregularly and coarsely roughened with projecting nodules of new bone. 2920

395. The lower half of a left femur, the cancellous tissue of the articular part of which has been everywhere exposed by ulceration, the articular surface of the inner condyle being also deeply pitted. The bone is diminished in weight, and is, in part, covered with newly-formed osseous substance for the lower 20 cm. of its length. 3218

396. The lower ends of a left radius and ulna, together with the remains of the carpus and metacarpus. The lower ends of the radius and ulna are normal. Of the carpal bones the lunar, pyramidal, and pisiform, except for very slight rarefaction of their compact surfaces, are normal. The scaphoid, magnum and unciform have been partially destroyed in their non-articular portions, the articular surfaces having to a large extent escaped; the surface of these three bones, except where covered with cartilage, is formed of cancellous tissue with thick trabeculæ. The trapezium and trapezoid are absent. Of the metacarpal bones, the first is absent; the second is represented only by the head and a pointed fragment of the shaft 13 mm. long; the third consists of the head and a thin pointed fragment of the shaft 2.5 cm. long; of the fourth the base has been nearly destroyed and the proximal end of the shaft thinned; the base of the fifth has been destroyed, especially in its anterior surface.

A. R., a boy aged 16, was admitted into U. C. H. under Mr. Beck on July 14, 1886. About four months previously he injured his left thumb in a fall; the thumb soon became swollen and was fixed on a splint. On admission there was an ununited fracture of the middle of the 1st metacarpal bone. The fracture was exposed by an incision and the soft rarefied ends of the fragments freshened; an antiseptic dressing and splint were applied (Mr. Beck's *Case-book*, 1886, vol. ii. p. 371). After leaving the Hospital the thumb was kept fixed for six months, and the patient then returned to his work, but the thumb was useless. About Christmas 1887 the hand became swollen and so useless that the patient left his work. When readmitted to U. C. H. on Oct. 15, 1888, the proximal part of the left hand was very much wasted, the carpus had almost disappeared, the thumb was represented only by the last phalanx attached loosely to the hand by a soft pedicle, and the proximal half of the 2nd metacarpal bone could not be felt. The skin was soft and smooth, the nails transversely grooved, and the whole limb wasted; there was no loss of sensation. Amputation was performed above the wrist. (Mr. Beck's *Case-books*, 1888, vol. ii. p. 113.)

### III.—Necrosis of Bone.

#### 1. SPECIMENS ILLUSTRATING THE CHANGES ASSOCIATED WITH THE OCCURRENCE OF NECROSIS OF BONE.

The most important changes following necrosis of bone, by whatever cause produced, are those concerned with the separation of the dead bone from the living and the final detachment of the former as a *sequestrum*. The dead bone acts as an irritant to the living bone around it and in its immediate vicinity, and sets up a rarefactive osteitis. The Haversian canals become enlarged, their solid walls disappearing



before the inflammatory new growth which fills them, and the compact tissue then becomes cancellous in structure. As the process advances the osseous tissue next to the dead bone becomes completely destroyed, its place being occupied by a layer of granulation-tissue on the surface of which pus forms. The earliest sign of the commencing separation of the dead bone is a groove beneath the periosteum (397), which in unmacerated specimens is filled with granulation-tissue (398). These changes progress most rapidly in the most vascular regions; thus we see that the groove of separation commences beneath the periosteum and in connection with the medulla and gradually extends to the middle of the compact tissue. When this has occurred all round the dead portion, the process of separation is complete (399, 400).

In the periosteum covering the dead bone similar inflammatory changes occur, as the result of which new bone is abundantly formed. The new bone does not adhere to the dead, but at its deep surface, where it is in contact with the dead bone, a vascular layer of granulations exists which forms pus abundantly. A loose portion of dead bone, therefore, lies imbedded in a mass of soft, highly vascular granulation-tissue. This must be remembered in looking at macerated specimens. The new bone formed around the dead fragment serves to maintain the strength of the limb during the separation of the dead from the living bone. The shell of new bone surrounding the dead is sometimes called the *involucrum* (401). It is usually soft and spongy, but in some cases, especially in the lower end of the femur, may become of ivory-like density (402). It is perforated by apertures for the exit of the pus formed from the granulations lining its inner surface. These openings are called *cloacæ* (403). The new bone may so completely surround the sequestrum that its removal may be impossible without trephining or otherwise enlarging the *cloacæ* (403). In other cases the gradual growth of the granulations may force the sequestrum towards the surface through an opening in the shell of new bone.

When the sequestrum has been removed the cavity left is filled up by the growth of the granulation-tissue, which undergoes ossification. The superficial layers of the new bone are gradually absorbed, and the bone thus becomes restored to somewhat its normal size and form.

In other cases the involucrum of new bone thrown out around the sequestrum is more or less imperfect, so that after healing is complete the bone presents a permanent loss of substance (404).

It frequently happens that, as the result of the widespread inflammatory changes accompanying the process of necrosis, the affected bone even at considerable distances remains permanently enlarged and its substance sclerosed (405). Further deformity may be caused by a bending or actual fracture of the newly formed involucrum (57, 406). The sequestrum separated as the result of necrosis necessarily varies much in extent. It may involve merely a scale of bone on the surface (407), the process being then spoken of as *exfoliation*. When more extensive the necrosis may involve the whole thickness of the osseous tissue, and in the case of the long bones may include a part or the whole of the circumference of the shaft in a part or the whole of its length (408, 409, 410). The necrosis may be limited to the cancellous tissue (*central necrosis*).

The sequestrum when removed always presents an extremely irregular form; the extremities or borders along which it has separated by ulceration from the living bone are more or less deeply dentated or prolonged, with irregularly pointed processes (411, 412). This shows the impossibility of removing dead bone completely by any operation till it has been separated by a natural process.

If the sequestrum includes part only of the thickness of the bone, the surface along which the separation occurs is irregularly grooved and pitted (412). In the recent state sequestra contrast with the living vascular bone by their white colour, and even in the macerated specimen a contrast in colour is more or less clearly marked. If, however, the sequestrum has been long exposed in the surface of a wound with decomposing discharges, its colour may change to brown or black (399, 411).

In necrosis resulting from injury, or from acute or subacute inflammation of the periosteum or medulla, the dead bone or *sequestrum* presents the appearance of healthy macerated bone (379, 410). In cases resulting from chronic inflammation it often shows the signs of the previous affection, either in rarefaction or condensation of its structure, or in the presence of new bone on its surface (397, 399, 413).

**397.** A frontal bone, in which an irregular transversely oval area of the outer table about 5 cm. broad and extending by a smaller process across to the left side has undergone necrosis and is in process of separation. The limits of the necrosed area are indicated by a groove of varying depth produced by ulceration of the living bone around. A scanty layer of dense osseous tissue has been formed upon the surface both of the part so mapped out and of the bone around it. On the inner aspect a similar groove of ulceration surrounds a portion of the bone corresponding to the central part of that affected on the outer surface. Between the grooves the skull is in many places perforated. The inner surface of the bone within the groove of ulceration shows marked evidence of previous inflammation and ulceration, but there is scarcely any new bone deposited upon it, whilst around it an abundant formation has taken place. 13135

The necrosis was the result of syphilis.

**398.** The inner half of a child's right tibia injected. Almost the whole of its shaft has undergone necrosis, the superficial extent of which is marked in two ways, viz. by the separation of the periosteum from the necrosed portion, and by an ulcerated groove around it, the formation of which, however, has at parts not yet commenced; this groove is filled with highly vascular granulation-tissue. The disease extends at either end as far as the epiphysis; and the layer of cartilage between the shaft of the bone and its epiphyses has been in part destroyed by ulceration; but it is not possible to determine precisely the extent of the necrosis of the shaft in these situations. 2408

The necrosis was the result of acute infective periostitis.

**399.** Part of the frontal bone of a boy, 11 years old. A large part of the outer table with the diploë, including the margin of both orbits, has been completely separated, after necrosis, from the rest of the bone. The surface from which it has been detached is considerably larger than that of the separated portion itself, the ulceration of the living bone having extended far beyond the margin of the dead; the border of that remaining is slightly more porous than natural, but new osseous tissue can scarcely be said to have formed upon it. The surface of the sequestrum is pitted, as if worm-eaten, by ulceration, and its irregularity is increased by a deposit of new bone with curling closely-packed lamellæ on the parts not ulcerated, showing that the necrosis of the separated portion was subsequent to inflammation, which led to deposition of the new bone and ulceration.

The surface from which the sequestrum has been separated is almost smooth, its cancellous spaces being diminished by thickening of their lamellæ, or closed in with a layer of compact bone. In one situation on the left side there are several small perforations of the inner table.

The sawn surface of the frontal bone is in places thickened; the diploë is for the most part much denser than natural, being in some situations scarcely distinguishable in texture from the outer and inner tables. 4254

The necrosis was probably the result of syphilis. The membranes of the brain were found after death to be unaffected; the whole of the skull was thickened and abnormally vascular.

**400.** The tibia and fibula of a pig, a portion of the fibula, near its middle, having undergone necrosis. The necrosed portion has been completely separated, and lies embedded in the granulation-tissue, which covers the living bone around and beneath it.

The necrosis followed the application of a hot iron.



401. A left tibia, in which a portion of the shaft extending continuously from end to end, and including in its middle third the entire thickness of the wall, has been completely detached after necrosis, and lies loose within a shell formed partly of new bone and partly of portions of the shaft which have escaped destruction, and which have been thickly covered with a coarsely nodulated layer of porous new bone. Numerous large apertures, or cloacæ, through which the sequestrum is visible, exist in the shell confining it. The chief of these are on the inner aspect, the largest in this situation measuring 2 cm. by 8 cm. The apertures on the other aspects are more or less circular, have rounded edges, and measure from 5 to 10 mm. in diameter. 237

402. The lower part of a right femur, within the walls of which, made very dense by chronic inflammation of their substance, a strap-shaped sequestrum 12 cm. in length lies loosely but irremovably enclosed. The lower end of the sequestrum is widely exposed through an oval opening in the front of the bone, about 4 cm. in length, and situated close above the upper border of the patellar surface; the edges of the aperture are smoothly rounded: this end of the sequestrum, which is deeply notched, is buried in the subjacent portion of the bone, and its surface is unlike that of the bone naturally occupying this position, as though the necrosed portion had moved downwards from some higher level. The upper end of the loosened piece lies within a small linear aperture on the posterior aspect about 15 cm. above the lower end of the bone; there is a third aperture about halfway down the inner aspect, and another minute opening lies equidistant between the two last mentioned. The knee-joint does not appear to have been diseased.

The shaft of the femur, as shown by the section, is quite solid and of almost uniform compact texture; and the portion forming the wall of the cavity in which the sequestrum lies is also extremely dense in texture, although the bone is not much increased in size. 3228

This extreme density of the new bone is a common condition in necrosis affecting the lower end of the femur.

403. The right tibia of a young person. Almost the entire shaft has undergone necrosis and lies hidden, except in a few places, within a thick case of new bone, through the cloacæ in which the smooth surface of the sequestrum (showing the entire thickness of the shaft to have become necrosed in these situations) is distinctly visible. Most of the cloacæ lie in series on the inner aspect; but one is situated on the front of the lower end and another about 5 cm. higher up on the outer surface of the new bone. With the exception of the highest, they have in general a circular outline, average about 8 mm. in diameter, and have smooth edges, around which, in some, a ridge of osseous tissue has been formed, probably in the granulations surrounding them. The new shell has become close-textured, and in places is quite compact. 3220

This specimen illustrates the inclusion of the sequestrum in the shell of new bone to such an extent as to render its removal impossible without enlarging the cloacæ or cutting away the new bone between them.

404. A left tibia, the upper two-thirds of the shaft of which have, on the inner side, been deeply excavated, as if scooped out, in consequence of the detachment of a necrosed portion of the bone, there being a complete absence of new bone formed over the situation of the separated sequestrum. The highest part of the shaft is extensively hollowed and contains a detached sequestrum of the cancellous tissue; the cavity communicates freely below with the long excavation above described, and there is also an oval cloaca 1.5 cm. in length in its posterior wall; the wall of the tibia 1 cm. below this is perforated by an irregular linear aperture 6 cm. in length. The extensive ulcerated surface is either covered with a granulated layer of new osseous tissue or smoothly healed; and the lower opening of the medullary canal is closed with new bone. 3195



405. The left femur of a young subject greatly increased in size and density as the result of the inflammatory changes accompanying necrosis of the shaft. Except at its lower extremity the shaft is greatly increased in thickness by the deposit of new bone on its surface, which in the upper third has been laid down in the form of imbricating plates. At its middle the shaft presents an unnatural curvature forwards and inwards, and below this level on the inner aspect of the bone is an elongated excavation resulting from the removal of a sequestrum. The floor of the cavity is in part formed by minutely porous and spiculated bone, evidently resulting from ossification in a layer of granulation-tissue. The section of the shaft in the upper third shows the bone to be quite solid, the medullary canal being obliterated, and the osseous tissue being slightly more open in texture than normal compact bone. Above this section the upper third of the shaft is occupied by a central cavity in which lies a small loose sequestrum. Two cloacæ lead into the cavity; one surrounded by a prominent lip of new bone in front of the small trochanter, and another large enough to admit the finger on the anterior aspect of the neck. 7789

A. S., a man aged 24, was admitted into U. C. H. under the care of Mr. Barker on March 20, 1897. Suppuration in the thigh followed a wound 8 years previously, and numerous operations had been performed for the removal of sequestra. On admission there were sinuses on the inner and anterior aspects of the thigh, and healed scars on the posterior and outer aspects. The femur was greatly thickened. The temperature was raised and the liver enlarged. On April 1 the femur was divided below the trochanters and its upper extremity removed; a week later the amputation was completed. Discharged, nearly healed, on May 11. (Mr. Barker's *Case-books*, 1897, vol. ii. p. 171.)

406. A right femur, the lower third of the shaft of which has been considerably narrowed at its upper part, and its surface extensively scarred by the healing which has followed the loss of portions of its substance in consequence of necrosis; its lower end is completely hollowed out, and opens by a long triangular aperture posteriorly, as a result of the destruction of its cancellous tissue either by ulceration or necrosis, or these combined. The shaft, where divided, is considerably enlarged, quite solid, and composed of dense cancellated tissue. At its middle the shaft is flattened laterally and is considerably bent, the convexity of the curve being directed forwards and outwards. The curvature has doubtless resulted from yielding of the shell of new bone formed as the result of necrosis. 5142

407. Three strip-like pieces of bone exfoliated from the tibia after erysipelas of the leg, and formed by the superficial layers only of its wall. 2899

408. Three sequestra from a femur, of nearly equal length, and each including the entire thickness of its wall and about a fifth part of its circumference. 2901

409. A sequestrum, comprising the greater part of the shaft of a child's humerus and including, save for a narrow strip along the posterior surface, its entire thickness. 5203

410. The greater part of the shaft of a child's radius, separated after necrosis, and removed during life. It was cut across to facilitate its removal. 2902

411. A sequestrum, 13 cm. in length, and in its lower part tubular, which was detached from a femur. A portion protruded externally, and has been discoloured of a deep brownish black. 2898

412. A sequestrum, 24 cm. in length, from the femur in an amputation-stump. It is extremely irregular, and in the greater part of its length it includes only a portion of the circumference. The borders are deeply notched, and its extremities prolonged into pointed processes. In some parts the sequestrum involved the

whole thickness of the compact tissue and here the surface is smooth. In the greater part of its extent, however, the sequestrum involved only the inner layers of the bone, and its outer surface is deeply grooved and pitted as the result of the process of ulceration by which, eventually, it was entirely separated from the still living bone outside it. 1054

413. A portion of one of the bones forming the roof of a skull, separated after necrosis; it is irregularly oval in outline, and measures about 6 cm. by 4.5 cm. Before its death and separation, however, both its surfaces, excepting the central part of the inner, have been irregularly excavated and pitted by ulceration; on the surface excepted a scanty filamentous layer of new osseous tissue has been formed, and the natural vascular channels are enlarged. The discoloration seen on its outer surface has resulted from the exposure of the sequestrum in an ulcer of the scalp. 2907

From a syphilitic patient who is said to have taken much mercury.

## 2. A SERIES OF SPECIMENS ILLUSTRATING THE CHIEF CONDITIONS IN WHICH NECROSIS OF BONE OCCURS.

a. *Necrosis following Injury*.—Any form of injury, whether mechanical, physical, or chemical, is capable of causing necrosis of bone. The death of the osseous tissue is determined in most cases not only by the direct effect of the injury on the bone but also by separation of the periosteum and the complication of the injury with sepsis or infective inflammation (necrosis produced by burn (400), necrosis following a blow or contusion (89)).

414. Two tibiae from dogs, in which the experiment was made, by Mr. Gulliver, of removing a portion of the wall and inserting pieces of the portion removed into the medullary canal. In the smaller of them a piece of the compact tissue, 4.5 cm. in length and 1 cm. in breadth, has been cut away from the middle of the shaft, the medullary canal being freely laid open. In the larger specimen the original aperture has apparently in part closed; but cloacæ lead through the wall of the bone into the interior, resulting perhaps from failure in the closure of parts of the opening made. The whole corresponds closely with what would result from the presence of a necrosed part naturally separated within the interior. 3232

415. The tibia of a rabbit, completely hollowed in consequence of the separation of sequestra, resulting from the introduction of lint into the medullary canal. Large apertures, by which many of the dead portions have escaped or been removed, exist in its wall, and other parts are in process of separation. 3229

416. A longitudinal section of the upper two-thirds of the tibia of a rabbit, into the medullary canal of which a narrow piece of the compact tissue of a human tibia was introduced fifteen months before the animal died. The portion introduced is about 3.5 cm. in length. In front of it a part of the wall of the tibia, almost as long as the portion of bone introduced into the medullary canal, is almost separated from the bone around; it presents much the appearance of a sequestrum in process of separation; but although the animal lived fifteen months, it is still firmly attached by its lower end to the rest of the bone. The wound healed without suppuration. New bone has been formed in front of the part described so as to completely cover it; in its deeper parts the new bone is cancellated in texture; superficially it is compact. 3230

“The animal became healthy and playful after the operation, and was kept as a pet in the house for upwards of fifteen months until it died. The necrosed bone was found to have suffered no change. It was separated from the tibia, which was somewhat thickened, by boiling.”—*Gulliver*, ‘*Medico-Chirurgical Transactions*,’ 1838.



417. The tibia of a rabbit, a longitudinal section being made of its upper two thirds. A narrow strip of the opposite tibia, about 3 cm. in length and weighing 1.1 grm., having been made to exfoliate by cauterization, was introduced into the medullary canal of the tibia shown in the preparation, forty-two days before the animal was killed. A portion of the compact wall of the tibia, almost as long as the piece of bone introduced, and including the entire circumference in the section, has undergone necrosis, the edges of the sequestrum being almost everywhere deeply undermined. New bone has been formed from the periosteum upon the superficial layers of the wall which have escaped necrosis; anteriorly the deeper part of the new bone is cancellated in texture.

The lower part of the tibia is unevenly enlarged by a formation of new osseous tissue upon it; in the new bone there are four or five small, round or oval, cloacæ, leading probably to portions of the superficial layers of the wall which have undergone necrosis; through the lowest of these openings a small sequestrum, involving portions of the deeper cancellous tissue, is visible; there is also a cloaca opening through the compact tissue a short distance below the head of the bone.

3233

"The piece of bone introduced was found to have neither diminished nor increased in weight."—*Gulliver*, 'Med.-Chir. Trans.', 1838.

It is evident that the operation induced acute osteo-myelitis, followed by necrosis of the inner layers of the compact tissue. As the piece of bone introduced was a sequestrum it must have been impregnated with the products of decomposition; this may in some measure explain the amount of disturbance it has caused, and which differs greatly from that in either the preceding or the following specimen.

418. A longitudinal section of the upper two thirds of a tibia, together with a portion of a femur of a rabbit. A portion of a human tibia 3.5 cm. in length has been introduced into the tibia of the rabbit. It is completely concealed from view by new bone deposited around it. The wall of the tibia itself shows no appearance of having been inflamed.

3231

The experiment was performed when the rabbit was about half-grown. "The animal continued active and healthy and grew to the adult size; it was killed fourteen weeks after the operation, when the foreign bone was found to be firmly agglutinated to the rabbit's tibia by new osseous tissue."—*Gulliver*, 'Med.-Chir. Trans.', 1838. Its presence has set up osteo-myelitis; but the inflammation has stopped short of suppuration, and the foreign body has become imbedded in a mass of granulation-tissue, which has subsequently undergone ossification, the new bone having now become somewhat dense in texture.

419. A frontal section of the upper extremity of a right tibia. In the outer tuberosity an area of bone 4.5 cm. in length by 2 cm. in thickness and involving the superficial compact tissue is in process of separation after necrosis. The surface of the necrosed portion is worm-eaten and around the greater part of its deep surface the surrounding bone is pale and soft as the result of rarefactive osteitis associated with the separation of the sequestrum, which is however still firmly fixed.

5718

The patient, a man aged 64, was admitted under the care of Mr. Heath in December 1881. Twelve years previously the right knee had been severely struck through a fall. Swelling followed, and three months later an abscess was opened and continued to discharge at intervals. On admission the knee was rather stiff, swollen, and the surrounding skin reddened. A sinus over the outer tuberosity of the tibia led to bare bone and communicated with the knee-joint. Amputation was performed through the condyle of the femur; gangrene of the stump proved fatal.

b. *Necrosis following Compound Fracture* (see also p. 7).—Necrosis is only likely to occur as the result of fracture when septic inflammation occurs in a wound communicating with the seat of injury to the bone. In simple fractures, however extensively comminuted, necrosis is practically never met with, and the same is true



of compound fractures if the wound runs an aseptic course. The extent of the necrosis varies greatly (421, 422).

**420.** A right tibia and fibula, toward the lower ends of which a compound comminuted fracture occurred. Large portions of the tibia have been detached by the fracture. None of the detached parts have retained their vitality, and a narrow line of the compact wall of the end of the upper fragment has undergone necrosis; the necrosed portion has been almost detached by ulceration of the living bone contiguous with it, and in one situation completely, the ulcerated surface of the bone beneath being here exposed to view. New bone has been formed in a longitudinally grooved layer, and afterwards in plates and nodules, upon the bone around, and encircles the living end of the shaft.

Similar changes may be observed upon the lower end of a portion of the fibula, 6 cm. long, which after being detached by fracture has, except in the situation noticed, retained its vitality. 2890

The anterior of the detached fragments of the tibia was extracted at the time of the accident, and the other three weeks afterwards.

The injury was caused by the patient falling down stairs. Suppuration ensued throughout the extent of the leg. Amputation was performed nine weeks after the accident, and the patient recovered.

**421.** A right tibia and fibula, the lower ends of the shafts of which have been extensively comminuted in a compound fracture. In the tibia the ends of the fragments have, in varying degrees, become necrosed; the dead portions are held to the rest of the bone only by a few slender rods of osseous tissue not yet ulcerated. In the fibula a larger portion of the end of the lower fragment, including the entire thickness of the shaft, has become necrosed, and is in like manner connected with the living bone below only by a few slender almost thread-like processes of bone. From the lower end of the upper fragment of the fibula a portion of the compact wall appears to have been completely detached, the end of the fragment being somewhat conical and its surface ulcerated. 2891

The patient was 30 years of age, and the injury was occasioned by a fall from a horse. The limb was amputated on account of erysipelas and the profuse suppuration which followed. The patient recovered.

**422.** The lower half of a left humerus, in which the greater part of the shaft has become necrosed and is in process of separation. The borders of the sequestrum are in places overlapped by portions of the superficial layers of the compact tissue, which have escaped necrosis, and are thickened by the deposition of a nodulated layer of porous new bone upon them. At the edge of the new bone this thin lamina of the compact tissue can be recognized in many parts beneath the spongy new formation. The upper end of the portion of the humerus shown is in process of repair after a fracture, which the necrosis has followed. The obliquely fractured surface, except where formed by the upper end of the sequestrum, is covered with a thin layer of delicate porous bone. 3119

**423.** Several portions of a tibia separated after necrosis, which has followed apparently, a comminuted fracture. Amongst them is a disk of bone which appears to have been removed by trephining from an excessively dense shell of new bone surrounding the necrosed fragments.

**424.** A sequestrum, 11 cm. in length, from the tibia of a boy seven years of age, separated after fracture; it includes the entire substance of the shaft. 2916

No shortening of the limb took place.

c. *Necrosis following Amputation*.—Necrosis only occurs in amputation-stumps when the operation is followed by suppuration, but the death of the bone is favoured by the damage to its vitality necessarily attendant upon the use of the saw and also by separation of the periosteum. The sequestrum may involve only a small fragment of the sawn surface (425). When more extensive the sequestrum presents certain characteristic features. It is tubular and conical; at the lower end it usually includes the whole thickness of the compact tissue; but higher up it affects less and less of the outer layers, until at its upper extremity it includes only the inner layers of the bone. Its upper extremity is extremely pointed, jagged, and irregular. On its lower end it shows the marks of the teeth of the saw as sharp and clean as at the time of operation, thus showing that pus has no solvent action on dead bone (427, 428, 430). The extension of the necrosis upwards, affecting the inner layers only, is due to inflammation and suppuration taking place in the medullary canal, and cutting off the vascular supply from within, whilst from without the supply from the periosteum is unaffected. At the lower end, where the periosteum has been stripped off by the saw, necrosis of the whole thickness occurs. The irritation caused by the presence of the sequestrum leads sometimes to abundant formation of new bone beneath the periosteum (430).

425. The upper third of a right tibia and fibula from an amputation-stump. The sawn edge of the compact wall of the tibia on the inner side, with a narrow strip of the crest, has necrosed and is partly separated from the living bone by a shallow ulcerating groove; in places the sequestrum is deeply undermined. The surface of the tibia beyond the ulcerating part is covered with a thin layer of newly-formed osseous tissue. 3915

426. The extremity of the femur from an amputation-stump. It is bluntly conical in shape and considerably enlarged by a deposit of spongy bone on its surface. The medullary canal is widely open and contains two loose sequestra, the longer of which evidently extended above the line of the saw-cut. 7489

The amputation had been performed for acute necrosis of the lower part of the femur.

427. Part of the shaft of a femur from an amputation-stump. A narrow ring of the sawn end, including the entire thickness of the shaft, together with pointed spike-like parts of the deeper layers of its wall above, has undergone necrosis. A wide and deeply ulcerated interval exists between the dead and living portions, the former having been almost completely detached. The living end of the shaft is encircled with a ring of new bone. 5296

The thigh was amputated for gangrene due to an aneurism. The stump became conical, and the end of the bone, as indicated by the black colour of the sequestrum, projected between the flaps. The portion of the femur shown was afterwards removed.

428. Two long sequestra, separated from femora after amputation. At the sawn ends a ring (in one incomplete) including the entire thickness of the bone has suffered necrosis; in the rest of their extent the deeper parts only have been involved, the separated portions having a long tapering shape. In the longer of them, however, a part of the surface-layer of the shaft has been included at the upper end, and upon this new osseous tissue has been in places deposited, showing it to have become necrosed at a somewhat later period than the rest. 3281

The necrosis thus spreading to the surface would give rise to the formation of an abscess opening in the limb some distance above the end of the stump. The length and irregular shape of the sequestra show the uselessness of attempting their removal by cutting off portions of the bone before the sequestrum is loose.



429. A long tube of bone, measuring 15 cm. in length, which was removed from a femur in an amputation-stump. For some distance along the posterior aspect the dead piece includes the whole thickness of the wall. 221

430. The upper third of a right femur, from an amputation-stump. Its shaft has, with the exception of a superficial layer of its wall, undergone necrosis, and lies ensheathed within a case of closely cancellated bone more than 1 cm. in thickness, and formed almost entirely of new osseous tissue; the layer of the compact tissue remaining has become cancellous in texture, and is indistinguishable from the new bone formed upon it. The lower end of the sequestrum includes the entire thickness of the shaft. A short distance below the great trochanter the new bone is perforated by three cloacæ. On the inner aspect a fourth cloaca passes upwards in the lower part of the neck of the femur and appears to have opened externally close below the head, perhaps into the hip-joint, for the head of the bone is superficially ulcerated. 1055

This increase in size of the bone would lead to considerable enlargement of the stump.

d. *Necrosis following Acute Suppuration in the Soft Parts around a Bone.*—Necrosis, often limited to the superficial layers of the compact tissue, not uncommonly occurs as the result of the separation of the periosteum caused by acute suppuration in soft parts surrounding the bone. As illustrations may be mentioned, necrosis of the tibia following cellulitis of the leg (347), of the phalanges in cases of whitlow (431, 432), and of the jaw as a result of ulcerative stomatitis (see Diseases of the Jaws). Necrosis of the articular extremities of the bones occurring as a complication of acute suppurative arthritis is a closely allied variety.

431. Portions of four phalanges in a state of necrosis, the other parts of them having been destroyed by ulceration, or these may have retained their vitality. 2952  
From patients with whitlow.

432. Necrosed portions of four terminal phalanges, from patients with whitlow. In two of them the articular part of the phalanx appears to have been unaffected. 2941

e. *Necrosis resulting from Acute Infective Suppuration of Bone* (see p. 90).

f. *Necrosis resulting from Tuberculous Disease of Bone* (see p. 99).

g. *Necrosis resulting from Syphilitic Disease of Bone* (see p. 117).

#### *Miscellaneous Specimens of Necrosis.*

In the following specimens, on account of the absence of any clinical history and of any sufficiently distinctive features, it is impossible to determine the cause of the necrosis.

433. Six ribs, from the third of which a long narrow portion of the upper border and pieces of the outer wall have been separated after necrosis. The surfaces resulting from the removal of the sequestra are smoothly healed, being formed by compact tissue resembling that of the rest of the bone. The ribs above have been fractured near their middle, a raised line of bone upon their outer surface marking the union of the fragments.



434. A rib from some quadruped. From its inferior or posterior border a portion, about 8 cm. in length, has been separated after necrosis. An abundance of new bone has been formed on the adjacent part of the rib and appears to have surrounded the necrosed parts on either side. 3111
435. A horse's rib, which presents about its middle a large spindle-shaped swelling caused by the abundant production of bone upon it attending the separation of a necrosed part; the new mass is in several places traversed with cloacæ leading from the cavity within. 3160
436. The humerus of some quadruped bisected, showing several irregular intercommunicating cavities within its upper end, resulting from the necrosis and subsequent separation of portions of the cancellous tissue. The spaces of the surrounding cancellous tissue are filled with sponge-like new bone, and osseous tissue of the same kind has been heaped upon the upper half of the shaft of the humerus, in places forming a layer about 2 cm. in thickness. Through the new bone and the wall of the shaft two or three winding cloacæ lead to the exterior. 3106
437. The lower two-thirds of a right femur, within the enlarged and hollowed shaft of which several long strips of the compact wall lay loosely enclosed, after having been separated after necrosis. Numerous apertures, the largest nearly 6 cm. in length, exist in the enclosing shell, and within one of these, on the posterior aspect, the lower end of one of the sequestra was situated. 3890
438. A left femur, from which, by an oval aperture about 3 cm. long and situated posteriorly near the junction of the middle and lower thirds of the shaft, a part has escaped after necrosis. The sequestrum has included part of the deeper layers of the wall above, with probably the whole thickness of the wall at the seat of the aperture. On the surface around irregular ridges and plates of new bone have been formed. 3191
439. The lower half of a left femur. The whole of the cancellous tissue within the lower end of its shaft has undergone necrosis, and is nearly separated by an ulcerated interval from the more superficial parts of the bone which enclose it. Above the outer condyle there is a large somewhat quadrilateral ulcerated opening in the enclosing shell, and other smaller ones exist above and to the inner side of this; in the anterior wall, also, there is an irregular elliptical aperture immediately above the patellar surface. A thin irregular layer of compact tissue has been formed on the surface of the lower third of the bone. 5008
440. The lower part of a left femur, the expanded lower end of the shaft of which is variously pitted and furrowed by the separation of necrosed portions from it, or by ulceration of its compact wall. The depressions resulting are for the most part smoothly healed. The whole bone has become dense and heavy from long-continued inflammation, and its medullary canal is quite filled with osseous tissue. 3217
441. A right femur, the lower articular portion of which has been deeply and irregularly excavated by ulceration, associated probably with necrosis of portions of the cancellous tissue. The cavity thus formed in the lower end of the bone is continued above by ulceration of the cancellous tissue into the medullary canal, which further communicates externally by an oval aperture on the outer aspect of the shaft about 12 cm. from the lower end, and by two smaller smooth-edged circular apertures higher up on the posterior aspect. In the highest part of the cavity there is a small detached sequestrum. It is most probable that the necrosis

of the shaft was the primary change, and that the disease has extended gradually by the medullary canal to the cancellous tissue of the lower articular end. The shaft of the femur is enlarged by the deposition of new bone upon it as far as its upper third. 3324

442. A longitudinal section of a left tibia, the upper third of the shaft of which is considerably increased in size and hollowed out by ulceration, associated probably with the necrosis of a portion of the cancellous tissue. The irregular cavity in the upper end of the bone, which is lined with a delicate layer of minutely porous new bone, communicates with the exterior in three situations—one anteriorly, where a flattened track, laid open by the section, leads directly forwards to the surface; the others, one at either end, pass inwards and outwards. The medullary canal, for about 4 cm. below the cavity, is plugged with thickly cancellated osseous tissue. A portion of the anterior wall of the tibia in front of and below the cavity described has also been destroyed by necrosis or ulceration; an irregular layer of dense new bone has been formed upon the rest of the surface as far almost as the middle of the bone. 3895

443. A left tibia and fibula. In the upper end of the shaft of the former, part of the cancellous tissue has undergone necrosis and lies almost detached in a cavity, from which three small cloacæ pass forwards through the inner wall of the bone, a fourth passing directly outwards and opening about 5 cm. below the articular surface and immediately in front of the interosseous ridge; posteriorly the cavity is freely open. The upper half of the shaft of the tibia is considerably increased in size by the formation upon it of porous new bone, which, together with a subjacent portion of the shaft, has, in one situation on the inner aspect, been undermined by ulceration which extends deeply and irregularly into the interior; the undermined part is apparently necrosed. 220

444. A longitudinal section of a dog's tibia, in which necrosis of parts of the shaft has been followed by the formation of a thick nodulated layer of porous new bone upon the surface of the living portions and beneath the periosteum of the necrosed portions. Near its upper end is the round aperture of a sinus leading from the cavity within. 3214

445. A portion of the shaft of a fibula, 20 cm. in length, which was removed by operation. It is greatly increased in size, being at its middle almost as large as a tibia, in consequence of chronic inflammation resulting from the irritation of a necrosed portion which lay in the cavity in the posterior part of the bone. The osseous tissue is throughout very dense, and no distinction exists between its outer and inner parts. 3610

Ten years before the time of the operation the fibula was injured. Sinuses discharging pus remained, some healing up at times. The necrosed bone was felt through the highest of the sinuses. The operation consisted in the removal of pieces of the fibula; at first a small piece was cut out, and finally eight inches of the bone. (See Mr. Massey, 'Lancet,' vol. i. 1840-41, p. 722.)

#### ACUTE INFECTIVE SUPPURATION OF BONE.

Acute spreading suppuration of bone resulting from an infection through the blood-stream is met with almost exclusively in the growing bones of young subjects. It occurs as a primary infection, but a similar form of acute infective suppuration may be secondary to a focus of suppuration elsewhere. Of an essentially similar nature also are the acute inflammations of bone following certain acute infective diseases, *e. g.*, typhoid fever and scarlet fever (458).



The primary affection results most commonly from an infection of the bone by the *Staphylococcus pyogenes aureus*. Evidence as to the site of entry of the organism is usually wanting, but in many instances the bone is prepared for its growth by some slight injury. In this respect the results of practical experience are in keeping with the experimental production of similar affections in the bones of animals.

In the long bones, which are those most commonly affected, acute infective suppuration may involve the shaft or one of the epiphyses. In the former case the affection is commonly known as *Acute Necrosis*, and in the latter as *Acute Infective Epiphysitis*.

*Acute Necrosis*.—The most common starting point of the inflammation is probably the delicate growing bone beneath the epiphysal cartilage (450, 452, 453, 455), but not uncommonly the inflammation begins beneath the periosteum (*acute infective periostitis*, 448), and much less commonly in the medulla (*acute infective osteomyelitis*). In whichever of these three positions the suppuration has its origin, the characteristic feature is its tendency to spread rapidly, so that in extreme cases the whole shaft, separated at each end from its epiphyses and completely denuded of its periosteum, may in a few days lie bare in the cavity of a huge abscess. As a result the shaft dies, and if the abscess be opened the periosteum forms new bone abundantly, making a complete shell around the dead bone, perforated here and there by cloacæ (465, 468). In other cases the periosteum may slough and consequently the formation of new bone may be very imperfect (462).

The epiphyses are very rarely affected and consequently the joints escape (453, 458). Occasionally, however, the suppuration extends through the epiphysis into the joint (461), or without the epiphysis being affected the abscess may extend into the joint superficially (450). If the patient survives, the whole shaft may ultimately be removed by operation as soon as the shell of new bone is sufficiently strong to support the limb.

In rare instances, as the result of very early evacuation of the pus by incision, the occurrence of necrosis may be prevented, and frequently the necrosis involves only a part of the shaft (462). The long bones most commonly affected are the tibia and femur; in the latter the necrosis frequently involves the popliteal surface (455, 456). The complications of acute necrosis are similar to those of other forms of acute infective suppuration, but more particularly may be mentioned the affection of several bones (453), pericarditis and abscess in the myocardium (447), pneumonia, and general pyæmia (452).

Several specimens of acute necrosis have been included in the Series illustrating the general pathology of Inflammation of Bone and Necrosis (*vide* 346, 371, 398, 403).

*Acute Infective Epiphysitis*.—Acute suppuration commencing in the epiphysis of a long bone is most commonly met with in infants. As a result the whole epiphysis may in extreme cases undergo necrosis and be separated as a sequestrum. Unlike acute necrosis, suppuration in the epiphysis is frequently followed by invasion of the neighbouring joint, and in fact in such an epiphysis as that of the upper end of the femur, which is altogether within the attachment of the capsule of the hip-joint, acute arthritis is an invariable result.

446. The lower part of a left femur, with the soft parts surrounding it. The periosteum has been separated from the bone except along part of the outer and anterior surfaces by suppuration beneath it. The inner surface of the separated periosteum is covered by a flocculent layer of inflammatory exudation. The section of the bone has been made about 1.5 cm. above the upper limit of the necrosis, and on the living bone a thin layer of new osseous tissue has already been formed. The commencing separation of the dead part of the shaft is evidenced by the presence of a shallow groove between the living and necrosed areas. The epiphysis is not



separated from the shaft. Ulceration has occurred along the margin of the articular cartilage of the outer condyle, which formed the lowest limit of the abscess-cavity.

7442

F. L., aged 14, was admitted into U. C. H. under the care of Mr. Heath, Oct. 7, 1895. On Sept. 29 he was sick and feverish, and complained of pain about the middle of the left thigh; delirium followed, and on Oct. 4 incisions were made into the thigh and pus was evacuated. On admission the limb was much swollen and pus was discharging through two incisions in the lower part of the thigh, in the outer of which the femur could be felt to be extensively bare; temperature at night 105°. On Oct. 9 amputation was performed through the middle of the thigh. The flaps partly separated, and at the end of November part of the end of the femur with a sequestrum was removed. Readmitted in March 1896 with abscesses in right leg and left arm; in the latter two small sequestra separated from the humerus. (Mr. Heath's *Case-books*, 1896, vol. ii. p. 116.)

447. The left clavicle of a child. It has been completely denuded of its periosteum, as the result of acute infective periostitis. In the greater part of its extent the surface of the bone is perfectly smooth, but at both extremities slight superficial erosion has occurred. The epiphysial cartilage of the sternal end remains attached but has undergone partial destruction.

8104

G. D., a boy aged 4 years, seemed perfectly well on the morning of Oct. 1, 1898. Later in the day he seemed ill and went to bed early. On the morning of Oct. 2 vomiting and shivering occurred, followed by a convulsion; at 10.30 A.M. he was admitted to the Victoria Hospital for Children with a temperature of 104°, and complaining of pain in the left arm and leg. Crepitations were heard at the bases of the lungs; there was no swelling of the arm or leg, but movement of the left arm caused pain. On the morning of Oct. 4 there was swelling and œdema of the left arm. Death occurred middle day. No history of injury or other illness. At the *post-mortem* examination the tissues around the left clavicle were found to be œdematous, and on incising the periosteum some thin pus escaped and the bone was found entirely loose in the abscess. There was also purulent pericarditis.

448. The lower part of a left femur in vertical section. The part of the shaft preserved in the specimen is bare except along a narrow strip of the anterior surface. In the latter situation the soft parts are still adherent to the bone and a layer of new osseous tissue has been formed upon it. The epiphysial line is normal in appearance.

6302

The patient, a boy aged 11, was admitted to U.C.H. under Mr. Heath on June 17, 1887. Illness began on May 23 with delirium and pain in left leg. Seven days later the thigh was swollen, and in the course of the next fortnight abscesses were opened in the thigh and at the inner side of the ankle. On admission the temperature was 102°·6; sinus in thigh enlarged and femur found bare on posterior surface of lower half; drainage-tube inserted. Amputation through middle of thigh on June 22. Patient made a good recovery. In the recent state the medulla of the lower part of the shaft and of the epiphysis was infiltrated with greenish-yellow pus and in parts sloughy. The knee-joint contained a little turbid fluid, and the synovial fringes were injected. The internal malleolus was bare over an area measuring 1½ inch. (Surg. Reg. Rep. 1887, p. 302, No. 1354.)

449. A left femur, with the upper ends of the bones of the leg and the patella, from a child. The entire shaft of the femur, with the exception of an irregular ring, about 3 cm. above the lower end, is necrosed. The upper of the necrosed portions is still connected with the living portion of the shaft; the lower was separated, except for a small part behind, which was fractured during the operation, so that the lower sequestrum is now perfectly loose. The periosteum is everywhere greatly thickened and confused with the surrounding soft parts; at the upper part a scanty formation of new bone has taken place. The articulation of the hip is completely destroyed, and the head of the femur separated by ulceration from the rest of the bone; small pieces of unossified cartilage are still adherent to it. The lower epiphysis of the femur is carious on both its upper and lower surfaces; and the ligaments of the knee-joint are softened but not destroyed. The cartilage covering the articular surface of the tibia is partly destroyed by ulceration. The articular surface of the patella is ulcerated over its central part, where ossification has taken place.

5366

The patient, two and a half years of age, was admitted, under Mr. Marshall, October 10, 1870. The left knee-joint was enlarged, flexed, and ankylosed: three sinuses, discharging pus, opened

in the neighbourhood of the joint; one of these, on the inner side, ran upwards beneath the vastus internus to the inner part of the thigh. The hip of the same side was much swollen, and on pressing over the trochanter pus flowed freely from the sinuses by the knee; the whole of the left buttock was considerably larger than the right. The limb was found, on measurement, to be shortened by an inch. December 8.—The patient was placed under chloroform and the sinuses probed, when it was found that bare bone was felt as far as the hip-joint. The limb was therefore amputated at the hip. The patient went on remarkably well after the operation, and on January 18, 1871, was well enough to be sent to Eastbourne.

450. The lower part of a left femur in coronal section, together with some of the soft parts covering it. Complete separation of the epiphysis has resulted from suppuration occurring between the epiphysial cartilage and the diaphysis. The suppuration has extended upwards beneath the periosteum, separating the membrane from the bone except along a strip less than 2 cm. broad on the anterior surface of the shaft, where the bone has retained its vitality and a thin layer of osseous tissue has been formed upon it. Small fragments only of the epiphysial cartilage remain, and the adjacent cancellous tissue of the shaft is ulcerated, most extensively in its inner part, where the irregular spaces in it are occupied by granulation-tissue. 2 cm. above the patellar surface a sinus leads down to the interval between the epiphysis and shaft; this sinus opens into the knee-joint, and the synovial membrane around it is covered with granulation-tissue. Over a small area the articular cartilage has been destroyed by ulceration. 7666

From a female child, aged 9, who complained of pain and swelling of left thigh, 3 days before admission and 2 days after a fall. On the 8th day an abscess was opened above the internal condyle, and the lower part of the shaft of the femur found to be bare. Six days later abscesses were opened below the right nipple and above the right knee. On the 19th day the lower epiphysis of the femur appeared to be separated from the shaft; on the 23rd an abscess beneath the left deltoid muscle was opened; on the 29th amputation was performed through the lower third of the thigh. The medulla of the lower part of the femur was infiltrated with pus; the abscess had burst into the knee-joint. When discharged on the 63rd day after the amputation the stump had nearly healed; the other abscesses had quite healed. (Surg. Reg. Rep. 1890, pp. 196 & 288, No. 712.)

451. The lumbar vertebræ, from the third of which the periosteum has been stripped on the right side by acute suppuration beneath the membrane. The denuded surface of the body extends to within 1 cm. of the middle line, and in this situation involves nearly the whole vertical extent of the vertebra. Traced outwards, the bare surface becomes gradually narrower, but at one spot reaches to the lower border of the bone. From the body the suppuration has extended on to the transverse process, completely stripping the periosteum from the anterior surface and upper and lower borders to the extent of 2 cm. The extensions of the abscess beyond these limits in the soft tissues on the front of the neighbouring vertebræ can be readily traced. On the right side the abscess extends upwards to the upper border of the 2nd lumbar vertebra in the substance of the right psoas muscle. On the left side an extension of the abscess is recognizable on the body of the 3rd lumbar vertebra, and lower down in the substance of the left psoas on a level with the body of the 4th lumbar vertebra. 7719 A

M. A. B., a girl aged 14, was admitted into U. C. H. under the care of Dr. Bastian on Feb. 10, 1896, complaining of pain in the abdomen, especially in the right iliac region. In the night of Feb. 5 she awoke with pain in the right side of the abdomen, which persisted. She was kept in bed, fomentations applied, and castor oil given. The pain increased and was attended with fever. On admission she lay on the back with the right leg drawn up; the expression was anxious; the eyes sunken; the lips dry and the tongue thickly coated. She complained of pain in the lower part of the back and abdomen and shooting down the right leg. The abdomen was slightly distended, the abdominal walls resistant, especially in the right iliac region and moving very little with respiration. Pulse 128; temperature on Feb. 10 and 11 varied between 102° and 104°·6. Suppuration about the cæcum was diagnosed, and on Feb. 12 the abdomen was opened in the right iliac region, but the cæcum and its appendix found to be normal; the transversalis fascia was œdematous; the abdominal wound was closed. High fever persisted, and the patient became delirious. Death occurred on Feb. 16, the temperature before death being 106°·4. (Dr. Bastian's *Case-book*, 1896, *Females*, p. 613.)



**452.** Part of a right hip-bone and femur, with some of the surrounding soft parts. As the result of acute suppuration beginning probably in the epiphysial line in the floor of the acetabulum, the iliac portion of the bone has become completely separated from the rest. The articular cartilage has been completely destroyed over the iliac portion of the acetabulum, and in other parts only small portions remain, the surface of the exposed bone being imperfectly covered with a layer of soft inflammatory exudation. The epiphysis of the anterior-inferior iliac spine is separated, and the adjacent part of the outer surface of the ilium is bare, irregularly pitted, and in part in process of separation as a sequestrum. Farther back on this surface a layer of inflammatory exudation superficial to the periosteum indicates an extension of the abscess. The outer surface of the bone is also denuded of its periosteum behind the acetabulum, and the presence of a well-marked groove around the bare patch shows that here also necrosis is in process. The inner surface of the bone presents an extensive bare area extending above and below the separated epiphysial line; the bare patch extends upwards to the brim of the true pelvis, backwards to the margin of the great sciatic notch, downwards to the upper border of the obturator foramen, and forwards to the pubic portion. The limits of the necrosis in this situation are marked by a well-defined groove.

The articular cartilage of the head of the femur has, except at two or three places around its margin, been completely destroyed and the surface of the bone is marked by shallow grooves of ulceration. 7506

The patient, a boy aged 16, was admitted into U. C. H., under the care of Mr. Barker, 3 days after a fall down stairs; he was delirious and the temperature was  $103^{\circ}\cdot 2$ . An abscess extending into the right buttock through the sciatic notch was opened and drained; numerous pyæmic abscesses were subsequently opened. Death occurred on the 50th day. At the P.M. examination, in addition to the disease of the ilium, there was necrosis of the right humerus and left tibia; an abscess in the substance of the right vastus internus; a small abscess in the right lung, and numerous abscesses in both kidneys. (Surg. Reg. Rep. 1896, p. 108.)

**453.** The lower part of the left femur, together with leg-bones of an infant. As the result of acute suppuration, probably beginning between the upper epiphysis and the shaft, the tibia has been stripped of its periosteum in the upper three-fourths of its length. The epiphysis is completely separated, and the adjacent part of the diaphysis superficially ulcerated. The femur and knee-joint are healthy. 7667

From an infant the subject of congenital syphilis. In the opposite limb the lower epiphysis of the femur was separated by suppuration. There was a gumma in the liver. (See Medical Series.)

**454.** The entire shaft of a child's tibia, removed by operation. On the inner, slightly convex, surface a portion of the wall limited anteriorly by an ulcerated groove which extends from end to end of the shaft by the side of the crest, and posteriorly by a second groove almost parallel with the first, has undergone necrosis; each of the grooves is filled with soft granulation-tissue. The living portion of the shaft is in places covered with a uniform layer of new osseous substance about 2 mm. in thickness; in others this has been removed, the edges of the new layer being abruptly broken; the posterior wall of the bone thus exposed is increased in vascularity. At either end of the shaft the ulceration appears to have extended inwards so as to destroy the cartilage of the epiphysis.

The patient, a boy 10 years of age, was kicked on the knee by a cow about a month before admission to the Hospital, at which time the leg was swollen, and bare bone could be felt from a sinus on the inner side of the leg, a short distance below the middle. Mr. Heath enlarged the sinus, separated the portion of new bone so exposed from the sequestrum, and removed the entire shaft of the tibia by means of sequestrum forceps. The wound was plugged with lint and the limb placed on a MacIntyre's splint. A few days afterwards the posterior part of the new bony shell was broken during the reappliance of the splint, and portions of the new bone projected into the wound. In the subsequent treatment of the case these portions underwent necrosis and were removed.

By the end of about two months a firm bond of new bone was formed in the place of the



natural shaft, and the use of a splint was discontinued. The patient afterwards suffered from an attack of erysipelas, but eventually did well, and was discharged nearly cured about three months after admission.—Mr. Heath, *Transactions of the Clinical Society*, 1877.

455. The lower half of the left femur from a young subject. On the popliteal surface a layer of the compact wall about 5 cm. long and 1 cm. broad and very irregular in outline has undergone necrosis and is surrounded by a winding groove of demarcation, the bone around over the whole popliteal surface being superficially ulcerated. Another small sequestrum is separating from the external supracondylar line. Immediately above the epiphysis posteriorly is an irregular transversely extended cavity, which completely perforates the bone, and in which small sequestra of the cancellous tissue were probably contained. The floor of the cavity is formed by the upper surface of the epiphysis, the cartilage of which appears to have been destroyed.

Above the anterior end of the cavity mentioned the compact wall of the shaft is extensively ulcerated and overlapped by a layer of new osseous tissue formed from the periosteum.

Except over those parts which are necrosed or ulcerated, the whole portion of the shaft preserved is covered with an adherent layer of new bone, most abundant about the lower end of the linea aspera.

2911

The suppuration probably started between the epiphysis and the shaft. A large abscess formed in the lower part of the thigh, the knee-joint being ultimately involved. The limb was amputated, and the patient, a lad, 16 years of age, recovered.

456. The left femur of a young subject. The lower two-thirds of the shaft are considerably enlarged as the result of the formation of new bone around an incompletely separated sequestrum. In its lower part the latter involves almost the whole circumference of the shaft nearly as low as the epiphysial line, and is widely exposed on the popliteal surface, where the ensheathing layer of new bone is deficient, and is represented merely by a pointed process overlapping the sequestrum and a bridge passing from above to below it. Anteriorly the involucrum is well formed and consists superficially of curling plates of compact or dense cancellous bone. In this situation the sequestrum is exposed through several cloacæ, the largest of which, 2 cm. across, is situated 1 cm. above the patellar surface. The inferior epiphysial line is obscured anteriorly by the new osseous deposit which extends to the margin of the articular surface. Posteriorly the articular layer of compact bone on the condyles is destroyed along its margin and undermined by ulceration of the subjacent cancellous tissue. The upper extremity of the femur is normal, but a thin layer of new bone extends on the shaft nearly as high as the small trochanter.

6702

The patient, a lad 17 years of age, was admitted into U. C. H., under the care of Mr. Heath, on October 11, 1890. Six months previously he was suddenly attacked with shivering and pain in the head and abdomen; during the night the left knee became painful and in a few hours swollen. A month later an abscess burst, and other openings subsequently formed. On admission the lower third of the left femur was enlarged and the surrounding soft parts indurated; two sinuses led to bare bone in the popliteal space; one of these was enlarged, but the sequestrum was found to be still attached. On April 2, 1891, the patient was readmitted with great swelling of the right upper arm and a sinus leading down to the upper end of the humerus. On April 25 the sinus was enlarged and the detached head and some loose sequestra removed; an incision into the elbow evacuated pus. On May 22 amputation was performed at the shoulder-joint. Death occurred on the 7th day. (*Surg. Reg. Rep.* 1891, p. 153, No. 2130.) The humerus is preserved in No. 371.

457. The right tibia and fibula of a young subject, the shaft of the former having undergone extensive necrosis. In the lower 7 cm. of the shaft the necrosis involves nearly the whole circumference, but above this level, for a further distance of 9 cm., it involves the inner surface only. The upper extremity of the shaft was also necrosed, and an oval blackened area on the inner surface lay exposed in the floor of an ulcer in the integument. Between the upper and

lower necrosed portions about 4 cm. of the shaft have retained their vitality in their whole circumference. The living bone is everywhere covered by a layer of new osseous tissue, which in many parts freely overhangs the necrosed areas. The new bone is of almost uniform thickness and longitudinally grooved, but in addition small osseous nodules of a porous texture are scattered over its surface. Where not hidden by the overhanging new bone a groove of ulceration everywhere marks the limit of the necrosis. Both the epiphyses are separated from the shaft, and the latter at each extremity is superficially ulcerated. The lower part of the shaft of the fibula is coated with new bone. 3681

**458, 459.** The bones of the right leg of a boy, and a wax model of the same, a longitudinal section having been made of the tibia. Proceeding from above, the following conditions are seen. Immediately below the cartilage of the epiphysis, and near the centre of the bone, there is a cavity lined with granulations, beneath which is somewhat dense cancellous tissue. This cavity communicates with the exterior posteriorly about 2 cm. lower down by a tortuous sinus. The whole of the upper fourth of the tibia consists of uniform dense cancellous tissue, in which there are no signs of a medullary cavity and no appearance of a compact wall. This condition represents the repair after removal of a sequestrum about six months previously. The sequestrum probably lay in the cavity above noticed, which is slowly closing by the growth of new bone from the granulations. Scattered in a mass of cancellous tissue, extending throughout the succeeding fourth of the tibia, are three small sequestra in the outer half of the bone and a single large sequestrum in the inner; the latter includes the whole of the compact tissue of the inner side of the tibia for a distance of about 6 cm., and is very imperfectly covered by the shell of new bone. Each sequestrum will be seen from the model to have lain in a cavity lined with granulations and containing pus. In the next fourth the compact tissue has disappeared anteriorly, and is replaced by dense cancellous bone, probably in consequence of inflammation. Behind, the bone, though not necrosed, has suffered in the general irritation, the Haversian canals of the compact tissue being enlarged in consequence of absorption of their walls before an inflammatory exudation from the vessels, so as to render the tissue more spongy than natural; and from the periosteum a considerable mass of new bone has been deposited in layers. In the lowest fourth a large sequestrum, including the whole thickness of the bone, is seen lying in a shell of new bone formed entirely from the periosteum, and perforated in front and behind with large cloacæ. The disease extends to the cartilage of the epiphysis, which is in great part destroyed, but, as is usual in such cases, the epiphysis itself is sound and the joint unaffected.

5366

The patient, a boy aged 16, was admitted, under Mr. Marshall's care, October 13, 1871. The necrosis followed some illness in June 1870, probably scarlet fever. In May 1871 the first abscess was opened and some pieces of bone removed. In October 1871 there were numerous sinuses discharging freely. The boy was suffering from advanced albuminoid degeneration of the liver and kidneys. Amputation was therefore considered safer than any partial operation, which would involve prolonged suppuration. The limb was amputated on December 2. The patient died of pyæmia on December 26, 1871.

**460.** A longitudinal section of the left tibia of a young subject, parts of the shaft of which have been detached after necrosis. From the lower end some of the separated portions have been removed, the bone presenting corresponding empty cavities having a granulated porous interior, as if in process of healing. In the upper third of the tibia part of a large sequestrum, about 8 cm. in length and including the whole thickness of the wall with the cancellous tissue of the interior, lies loosely locked beneath the surrounding parts of the new bony shell, which in this situation has been formed exclusively by osseous tissue produced from the separated periosteum. The texture of the lower part of the wall of the



bone is uniformly cancellous, and this portion appears also to be formed solely by new osseous tissue. Large irregular gaps exist in the new bone surrounding the upper sequestrum, and in that forming the cavities in the lower end are several short canals which open externally by circular apertures about 6 mm. in diameter. In the upper end of the bone is a carious cavity which extends deeply into the epiphysis, and in the macerated specimen opens on the articular surface; it does not appear, however, that the articular cartilage was perforated, as no mention is made of the joint having been diseased in the history of the case. 222

The patient died of erysipelas after an attempted removal of the sequestrum.

461. The left tibia and fibula, with the lower end of the femur and patella, from a young subject. The shaft of the tibia is enlarged throughout as the result of inflammation, the enlargement being accurately confined to the shaft of the bone. A portion of its wall, about 6 cm. in length, has been completely detached after necrosis, the necrosed part being, on the inner side, very imperfectly enclosed.

Immediately below its upper epiphysis the head of the bone is completely hollowed out, the cavity within it being widely open anteriorly; and the epiphysis has been perforated at its anterior and outer part so as to lead to secondary disease of the knee-joint. The knee-joint is flexed to a right angle, the tibia being also displaced outwards and backwards, and rotated outwards for about 45 degrees.

The surface of the inner condyle of the femur is partially destroyed by ulceration, and both condyles are apparently ankylosed to the articular surfaces of the tibia by osseous substance. It would appear as if the epiphysis of the tibia had, after becoming united to the femur, been displaced inwards and somewhat backwards on the upper end of the shaft. New bone has been formed within the angle on the inner side, giving an appearance as if the upper end of the shaft of the tibia had partaken in the displacement.

All the bones, as well as the new osseous tissue uniting the tibia and the femur, are light and greasy from atrophy. 241

The parts were removed by amputation.

462. The diaphysis of a right tibia, the greater part of the upper half of the shaft of which has been separated from the rest of the bone after necrosis. In two situations the entire thickness of the wall has perished, whilst over the rest of its extent the superficial layers of the compact wall have been destroyed by ulceration. The sequestrum lies loosely and incompletely encased within a bony shell formed, in part, by portions of the shaft which have retained their vitality, but chiefly by new bone produced from the separated periosteum. At the highest part of the preparation, on the outer aspect, a portion of the cancellous tissue has undergone necrosis and is deeply undermined; posteriorly a considerably larger portion, continuous both with this and with the main sequestrum, has also become necrosed. The enclosure of the sequestrum is very incomplete; this has possibly been occasioned by sloughing or ulceration of the soft parts and the periosteum, since a considerable area of the anterior part of the sequestrum is discoloured by exposure to the air. 2633

463. The upper half of a left tibia, from a young subject. A large part of its shaft, together with some of the cancellous tissue of the upper end, has been detached after necrosis, which on the outer aspect has involved the whole thickness of the wall. The formation of new bone is very imperfect. On the inner side the end of the sequestrum and the adjacent portion of the living bone are grooved by a trephine. 3122

464. A right tibia and fibula. A part of the middle of the shaft of the tibia has undergone necrosis, and lies detached within a shell of new bone, through a small oval aperture in the inner wall of which the necrosed part is exposed to view. About

1 cm. below this is an aperture, 5 cm. long and 2 cm. broad, by which a sequestrum was extracted after enlargement of a cloaca in this situation by trephining. The cavity from which the sequestrum has been removed is covered with a nodular layer of recent new bone, produced by ossification of the granulations which have grown from its sides. Within the lower end of the tibia, also, a sequestrum has been separated, the cavity within which it lies communicating with the exterior by two cloacæ on opposite sides of the bone about 5 cm. above its articular surface. The shaft of the tibia is enlarged throughout its extent, and almost uniformly, by a deposit of new bone; a thin imperfect layer of new bone has been formed, also, on the shaft of the fibula, especially near its lower end. 2892

The limb was amputated for abscess in the knee-joint. The patient, aged 18, recovered. No communication is discoverable between the cavity in the bone and the knee-joint.

465. The right tibia of a young subject, portions of the deeper parts of the shaft of which have, at each end, been removed after necrosis. From the upper of the cavities remaining three cloacæ pass to the exterior, opening upon the inner and posterior aspects. The cavity within the lower end is widely exposed anteriorly, and cloacæ of considerable size open on every side of the bone. 3069

466. The lower half of the right femur, from a young subject. A piece of the lower part of the shaft, about 10 cm. long and posteriorly including the entire thickness of its wall, has been completely detached after necrosis. The sequestrum lies loosely between two firm columns of bone—a posterior entirely of new formation, and an anterior formed in part by that portion of the wall of the shaft which has retained its vitality.

The lower end of the bone is expanded; there is an oval cloaca in its anterior wall opposite the lower end of the sequestrum. As seen in the section, the medullary canal is completely filled with osseous substance, and the wall of the bone has become coarsely cancellated in texture from long-continued inflammation. 3884

467. The upper part of a humerus of a child, about eight years of age. The portion of the shaft shown in the preparation has undergone necrosis, and is completely detached from the rest of the bone. Surrounding the upper part of the sequestrum, and concealed beneath the muscular structures, are fragments of a new osseous shell formed over it. The necrosed portion of the shaft is half divided by a saw-cut about 3 cm. below the head of the bone. 5367

The shoulder was much swollen, and sinuses opened at each side of the deltoid. There was no grating on rotating the humerus, but a probe passed upwards to such a distance that it was believed to be in the joint; at this point the probe came on bare bone. The humerus for some inches below the joint was much enlarged. The diagnosis made was caries of the shoulder-joint, and the operation of excision was commenced. When the head of the bone was disarticulated it was seen to be quite healthy; it was considered safer to treat the case as a compound dislocation, and to remove the head of the humerus. A saw was therefore applied to the thickened shaft about an inch below the head. After being sawn half through the head came off in the surgeon's hand, bringing with it a long sequestrum, including the whole of the upper part of the shaft. It was then evident that the case was one of necrosis of the shaft, extending upwards as high as the epiphysis.

The child recovered with a very useful arm.

468. The shaft of a humerus, considerable portions of which have, throughout its length, undergone necrosis, which in the highest of the portions has involved the entire thickness of the wall. A cloaca corresponds with each of the sequestra. The largest of the cloacæ is upon the outer aspect of the humerus close below the great tuberosity; the others are situated one on the same aspect near the middle, the other in the front of the shell enclosing the sequestra, the several openings being equidistant. The edges of the cloacæ are smoothly rounded. 3278

469. The lower part of a leg removed by amputation and injected. The bones have been displayed by two vertical sections. The whole of the part of the tibia



preserved in the specimen is, with the exception of the epiphysis, enlarged and sclerosed. The interior of the lower part of the shaft presents an irregular cavity lined with a thick layer of granulation-tissue. The upper end of the cavity is freely open on the anterior aspect of the bone, in which position a large granulating surface is present in the skin around an opening communicating with the cavity. Other openings in the skin mark the position of cloacæ extending into the lower end of the cavity; two of them are situated on the inner and two on the outer aspect of the limb. New bone has been deposited on the lower end of the shaft of the fibula in the neighbourhood of the last-mentioned cloacæ. The ankle-joint is normal.

5503

The patient, a female child, aged  $4\frac{1}{2}$ , was admitted, under Mr. Heath, July 16, 1880. Her illness began on June 20 with pain in the right foot, the diagnosis being "acute rheumatism." An abscess formed over the tibia and burst. After admission abscesses about the lower end of the tibia were opened and sequestra removed after cutting away part of the ensheathing new bone. On September 22 amputation of the leg was performed on account of failing strength. (Mr. Heath's *Case-books*, 1880, vol. i. p. 576.)

#### TUBERCULOUS DISEASE OF BONE.

Tuberculous disease of bone is characterized by the formation of a deposit similar in every essential respect to that which characterizes the disease in other parts. In whatever part of a bone the disease takes origin there results the formation of a deposit of granulation-tissue, which, by reason of its infective nature, steadily invades the osseous substance. As a rule caseation or fatty degeneration occurs at an early stage in the central part of the tuberculous deposit (477), and results in the formation of a soft yellowish cheesy material. This may undergo further disintegration and liquefaction, with the formation of a so-called chronic abscess (476); the fluid contents of such an abscess are usually thin and curdy, thus differing widely from the thick creamy pus of an acute abscess. The cavity of the chronic abscess is lined with a layer of tuberculous granulation-tissue which may continue to extend into the surrounding bone and undergo progressively the changes above described. The formation of a chronic abscess, although an usual, is by no means a constant, result of tuberculous disease, and in the bones it is not uncommon for extensive destruction to occur without suppuration; under these circumstances the caseous products may undergo calcification instead of liquefaction. Should arrest of the disease occur the tuberculous granulation-tissue may become fibroid, calcareous deposits may become encapsuled, and even the fluid contents of a chronic abscess may become absorbed (493, 504). Grey granulations, which form so striking a feature of the disease in many of the viscera, are rarely recognizable in the tuberculous granulation-tissue occurring in the bones. Examined microscopically, the granulation-tissue may present definite tubercle systems in which giant cells, epithelioid cells, and lymphoid cells are recognizable, but more often the epithelioid cells are scattered irregularly through the granulation-tissue, and only a few giant cells are present. The tubercle bacilli are difficult to demonstrate, being present in very small numbers.

Tuberculous disease of bone begins most commonly in the cancellous tissue (477, 533), less frequently beneath the periosteum (516, 482) or in the medullary cavity (519). The compact tissue may be attacked by extension from one or another of the above situations. The changes produced in the osseous tissue itself by tuberculous disease are in no essential respect different from those occurring in other inflammatory conditions.

In the *cancellous tissue* tuberculous disease first manifests itself by a deposit of granulation-tissue in the cancellous spaces. By a process of rarefactive osteitis the osseous trabeculæ around the deposit are thinned and then destroyed; thus

the adjacent cancellous spaces are thrown open one into another and their normal contents are replaced by granulation-tissue. In this way considerable loss of substance in the bone may occur (central tuberculous caries, 533). As a result of changes in the tuberculous tissue a chronic abscess forms in the bone, and the further stages of the disease consist in the slow extension of the abscess to the surface of the bone, with subsequent perforation of the periosteum and overlying soft parts, and the production of one or more sinuses leading into the interior of the bone. In the osseous tissue around the diseased area more or less thickening of the trabeculae may occur, and if the central disease has been of long standing a considerable deposit of new bone may be formed beneath the periosteum (364). It frequently happens in tuberculous disease of cancellous bone that larger or smaller masses of the osseous tissue, being entirely isolated by the extension of the disease, are separated as sequestra, which are usually soft and spongy (necrotic caries, 510). In other instances considerable loss of substance may occur without suppuration, the tuberculous products, instead of undergoing liquefaction, becoming dry and often calcareous (dry caries). When healing occurs the thin and partly destroyed osseous trabeculae become thick and smooth, and the enlarged cancellous spaces partly or completely filled with new bone (368, 481).

When tuberculous disease begins, as occasionally happens, in the *medullary cavity* of a bone (tuberculous osteomyelitis) the normal medullary tissue is gradually replaced by granulation-tissue, which in turn softens and forms a chronic abscess. The abscess then perforates the bone at one or more places and discharges on the surface. Frequently more or less necrosis of the compact bone occurs (519), and a considerable deposit of new osseous tissue may be formed beneath the periosteum.

When a tuberculous deposit forms beneath the *periosteum*, as is not uncommon in the ribs and vertebrae, the superficial layers of the compact bone are gradually eroded by the tuberculous tissue (superficial tuberculous caries, 482, 516), whilst in some instances the process is associated with the separation of superficial sequestra.

In many cases of tuberculous disease of bone the rapid extension of the abscesses and the widespread inflammatory changes in the osseous tissue are the result of the complication of the disease with simple septic inflammation (495).

It must be clearly understood that in macerated specimens the chief evidence upon which the recognition of tuberculous disease of bone is based—viz. caseous deposits and chronic abscess—is wanting. Many such specimens, in which more or less extensive loss of substance has resulted evidently from chronic inflammation, have, however, been included in the Series although positive evidence of their tuberculous nature is wanting, especially in the absence of any clinical history.

Specimens illustrating tuberculous disease of the articular extremities of the bones are preserved in the Series of Tuberculous Disease of the Joints.

## TUBERCULOUS DISEASE OF THE SKULL.

Tuberculous disease of the flat bones of the skull is rare. It affects chiefly the frontal bone, but the parietal or occipital may be affected and more than one focus of disease is sometimes present (470). The disease usually begins in the diploë and may rapidly lead to the separation of a sequestrum involving the whole thickness of the bone (*perforating necrosis*, 470). A chronic abscess forms beneath the scalp and may also extend between the bone and dura mater. Tuberculous disease not uncommonly starts in the middle ear and may lead to extensive caries of the mastoid and petrous portions of the temporal bone.

Tuberculous caries of the face bones is most common about the lower margin of the orbit, but it may affect the bony walls of the nasal cavities. Caries of the alveolar borders of the jaws of tuberculous origin (472) probably begins usually in connection with a carious tooth.



470. The calvaria with the dura mater of an infant, showing the effects of several foci of tuberculous disease in the bones. In the lower part of the left parietal bone is a rounded perforation nearly 2 em. across, with smooth shelving edges and regular outline; the perforation is closed by the dura mater which is adherent around its margin. In an almost similar position in the right parietal bone there is a similar perforation, over which the scarred skin is adherent to the dura mater. In the left half of the frontal bone is a third similar but rather larger perforation; midway between this and the coronal suture is a small triangular depression involving only the outer table. In the position of the occipital protuberance there is an irregular perforation nearly 3 cm. across. Around its lower part the margin is smooth, but the upper border is irregular and worm-eaten, the disease being still active in this situation. The dura mater, except where adherent to the margin of the perforations, presents a perfectly normal appearance. 6277

The patient, a well-nourished female child, aged 10 months, was under the care of Mr. Bilton Pollard in the North-Eastern Hospital for Children. There were four chronic abscesses on the skull—two over the frontal bone and one over each parietal. Each abscess was opened, and a quantity of caseous granulation-tissue removed by scraping. The smallest healed, but the others remained as sinuses, and a fifth abscess formed over the occipital protuberance and was opened and scraped. Four months later all the sinuses were opened up and a sequestrum removed from each. Three of the abscesses healed, but that over the occipital protuberance remained open. The child rapidly wasted, and died two months later. The bronchial glands were caseous, and there were a few patches of caseous tubercle in the lungs. The mesenteric glands were enlarged, but not caseous. The granulation-tissue scraped from the abscesses on the skull presented the microscopic structure of tubercle, but no bacilli were detected in it. (Trans. Path. Soc. 1887, vol. xxxviii. p. 284.)

471. The anterior part of the base of a skull, in which the whole of the ethmoid bone, with the exception of part of the right lateral mass, has been destroyed by tuberculous disease. As a result, a large irregularly quadrilateral opening exists between the anterior fossa of the base of the skull and the nasal cavity. The bones surrounding the opening are extensively pitted by caries; the orbital plate on each side is perforated, and the anterior part of the body of the sphenoid has been destroyed. The under surface of the dura mater, in the position of the opening above described, is covered with an irregular layer of granulation-tissue, and in the same situation the upper surface of the membrane has been roughened by inflammation. The upper half of each nasal bone is carious. 6801

A. W., a female child aged 12, was admitted into U. C. H., under Mr. Beck, on April 23, 1891. From the age of 7 she had suffered from enlarged glands in the neck; for 2 months there had been swelling and tenderness at the root of the nose. On admission a chronic abscess extended from the glabella to the lower end of the nasal bones and outwards on each side to the inner canthus. There was no unusual discharge from the nose and no obstruction; enlarged glands in the neck and tuberculous patches in the skin below the jaw. The abscess over the nose was opened and the nasal bones found bare. Discharged May 6; re-admitted May 21, complaining of failing sight: there was double optic neuritis. When discharged on Sept. 5 the patient was quite blind; there was very little discharge from the abscess. Re-admitted Nov. 28 on account of headache and drowsiness. Both eyeballs were slightly prominent, the left side of the face was flattened, and the tongue deviated to the right. Drowsiness increased, and the patient died on December 28. There was extensive tuberculous meningitis. (Surg. Reg. Rep. 1891, p. 50, No. 999.)

472. Part of a left upper jaw. The alveolar border corresponding to the second bicuspid and first and second molar teeth has been extensively destroyed by caries. The diseased surface, which presents a rough open texture, extends posteriorly around the outer part of the socket of the wisdom-tooth, which still remains *in situ*. 8184

From a male subject in the dissecting-room. In the recent state the diseased surface of the bone was covered with granulation-tissue.

## TUBERCULOUS DISEASE OF THE VERTEBRÆ.

Tuberculous disease may attack almost any part of a vertebra. It is occasionally seen in a transverse process, spinous process, or articular process, but in the vast majority of cases it begins in the body. Here the disease commonly originates in the cancellous tissue in the neighbourhood of the epiphysal plates (499); but it appears frequently to begin beneath the periosteum (482, 483), and possibly in some instances it may begin in an intervertebral disk (499). Several specimens illustrate extensive destruction of a disk and caries of the corresponding bony surfaces (478, 498), but it is impossible to say that the disease began in the fibro-cartilage and not in the bone. In many cases the tuberculous products soften and a chronic abscess forms (caries with suppuration). Extensive disease may, however, occur without abscess formation (dry caries). Sequestra are often present (necrotic caries, 479, 491). The disease may be limited to the body of one or two vertebræ or may extend to many.

In all cases, as in tuberculous disease of other bones, loss of substance is the most important result, and in consequence of this the spine frequently yields from the weight of the upper part of the body and the action of the muscles of the trunk, and is bent forwards so as to cause a projection of the spinous processes backwards (angular curvature of the spine). In the lumbar region, on account of the direction of the normal curve, angular curvature is necessarily preceded by a stage in which the normal curve is more or less obliterated (500, 506). Extensive disease of any part of the column, especially if limited to the surface of the vertebral bodies, may occur without any deformity (481). The deformity is most pronounced when the dorsal region is affected (485); when one or two vertebræ only are destroyed, the curvature is sharp and angular; when a large number are partially destroyed, the curve is proportionately longer and more gradual.

Should recovery take place, the open cancellous bone becomes more or less sclerosed and smooth (481, 482); any granulating surfaces which have been brought into contact unite, and ossification of the granulation-tissue following, the diseased vertebræ become welded together by bone (500, 488). Not uncommonly, also, bony ankylosis occurs between the articular processes (501), and less commonly between the laminae and spinous processes (488, 506).

Tuberculous disease of the spine is most common in the lower dorsal and upper lumbar regions (487-507), but any part, including the cervical region (473-476) and the sacrum (495), may be affected. In rare instances the disease may attack two or more different parts of the column (477, 509).

When suppuration occurs, the pus forms a large collection enclosed in a sort of sac formed by the surrounding tissues condensed by pressure and chronic inflammation (chronic abscess). This burrows in the direction of least resistance, and thus appears in different positions according to the situation of the disease. In the cervical region the abscess is usually found behind the pharynx—*retropharyngeal abscess*. (No. 476 shows an abscess from dorsal caries similarly situated behind the œsophagus.) In the dorsal and lumbar regions the abscess may pass backwards along the course of the dorsal or lumbar vessels—*dorsal or lumbar abscess*; it may extend downwards in the sheath of the psoas muscle on one or both sides—*psoas abscess* (494, 495, 496); or it may follow the intercostal or lumbar vessels forwards into the wall of the chest or abdomen. In the lower lumbar and sacral regions the abscess may be limited to the hollow of the sacrum or may extend to the buttock through the great sciatic notch. In any situation the disease may strip the anterior common ligament extensively from the bones, and so cause secondary superficial caries of the bodies of the vertebræ; should decomposition occur in the abscess after it has been opened, this denudation of the bone may take place rapidly and many vertebræ be laid bare and the intervertebral disks be destroyed by a process of maceration (495).



The destruction of the vertebral bodies may open the spinal canal, but the dura mater usually becomes adherent and thickened, and prevents the cord being actually invaded by the disease (493). Even when the curvature is extreme the spinal canal usually maintains its normal size (488, 489); and when the spinal cord is compressed, this is due, not to the bony deformity, but to the extension of a chronic abscess or mass of caseous granulation-tissue backwards into the canal (476, 493, 504). Thus slow compression of the cord may occur without the presence of any angular deformity, and on the other hand the symptoms of compression may subside whilst the curvature remains unchanged or even increases (493).

By a study of many of the specimens the student will readily see that in order that recovery may occur, it is very important that the weight of the head and shoulders should be taken off the spine and the diseased surfaces prevented from rubbing forcibly against each other; and, on the other hand, that if the angular deformity be reduced by forcible extension, so wide a gap would be left between the diseased surfaces that the chance of firm bony consolidation would be much diminished.

**473.** The right halves of the upper four cervical vertebræ. In the lateral mass of the atlas immediately above the inferior articular surface is a caseous deposit measuring 1 cm. by .5 cm. in its most superficial part. Around the deposit the surface of the atlas is superficially carious, and from it an abscess leads downwards and backwards beneath the transverse process of the atlas on to the lamina of the axis, the lowest limit of the disease consisting of a yellow caseous deposit on the surface of the lamina of the third cervical vertebra. The joint between the lateral mass of the atlas and the axis is healthy. 7223.

**474.** The lower four cervical vertebræ. Anteriorly the bodies of the 4th, 5th, and 6th vertebræ have been in varying degrees destroyed by ulceration; that of the 7th is wholly wanting, and its superior articular processes are ankylosed with the inferior of the 6th. The column is bent forwards almost to a right angle. 1830

**475.** The upper six cervical vertebræ, with the adjacent part of the occipital bone, the arches having been removed. The bodies of the fourth and fifth vertebræ have been extensively destroyed by caries, the posterior surface of the fourth and the right half of the fifth having escaped. The upper surface of the body of the sixth is also carious, and new bone has been thrown out on those parts of the fourth and fifth bodies which remain and in a thin layer on the adjacent vertebræ. 3712

On Feb. 5, 1844, the patient, a man, fell from a carriage and was for a short time rendered insensible. No inconvenience, however, followed till a fortnight afterwards, when pain in the head, neck, and left arm supervened, with inability to raise the arm; nodding and rotation of the head, also, were imperfect. These symptoms increased till the head could not be moved without steadying it with the hands; and pain on swallowing appeared. On May 4 the patient was admitted to U. C. H. under the care of Mr. Quain. By August 28 all the limbs were paralysed, and the contents of the bladder and rectum passed involuntarily; death ensued on Sept. 12. In the recent state of the parts there was a curve forwards at the seat of injury, and a prominence in the spinal canal beneath the posterior common ligament, in consequence of inflammatory exudation. Around the third, fourth, fifth, and sixth cervical nerves on the left side the inflammatory deposit was in great abundance, and the nerves themselves red and inflamed. The spinal cord was uniformly soft and pulpy, and was compressed by the projection within the canal.

**476.** The cervical and upper part of the dorsal regions of the spine in vertical section, together with part of the corresponding ribs and adjacent soft parts. The spine presents a gradual curvature backwards at the junction of the cervical and dorsal regions, the most prominent part of the curve being formed by the second dorsal spine. The curvature has resulted from an extensive loss of substance in the bodies of the upper five dorsal vertebræ. The body of the first has been destroyed in its lower half, those of the second and third have entirely disappeared, the postero-inferior angle of the fourth alone remains, whilst the body of the fifth

and the disk between it and the fourth have been destroyed only anteriorly. By the falling together of the parts above and below the diseased area, the first and fifth dorsal vertebræ have come to be separated by a distance only equal to one normal body. The cavity resulting from the destruction of the bodies is lined with caseous material and is continued forwards into a thick-walled abscess which lies behind the trachea and œsophagus, both of which are displaced forwards. In the right wall of the abscess-cavity an opening leads into two diverticula, one of which passes upwards in front of the vertebræ, and another, as large as a walnut, projects into the right pleural cavity immediately below the first rib, and in the recent state exerted slight pressure on the right bronchus. Both these diverticula contain solid cheesy material. The section through the spinal canal shows it to be encroached upon and the cord compressed, partly by the bulging backwards of the abscess-cavity, which occupies the position of the vertebral bodies which have been destroyed, and partly by a caseous mass which is seen in section between the arches and the theca and probably completely surrounded the latter. At the level of the compression the dura mater is thickened and adherent. The root of the fourth dorsal spinous process has been destroyed by the disease, and on a level with the interval between the second and third processes a small abscess extends from the spinal canal into the muscles of the back. On the right side of the neck in front of the large vessels there is a considerably enlarged lymphatic gland.

5445

H. S., an emaciated boy, aged  $\frac{1}{2}$  years, was admitted into U. C. H., under Mr. Hill's care, May 2, 1879. Unless supported, the head fell forwards, so that the chin rested on the sternum. Respiration was embarrassed, and death occurred on the sixth day. The bronchi of the right lung contained muco-pus; the left lung was solid throughout; neither contained tubercle. The bronchial and tracheal glands were caseous. The left part of the abscess-cavity, which is not preserved in the specimen, projected only slightly into the left pleural cavity, which was obliterated by adhesions. No reference is made in the notes to any symptoms of compression of the spinal cord. (Mr. Hill's *Case-books*, vol. ii. 1879, p. 360.)

477. The lower ten dorsal and the first lumbar vertebræ in median section. The normal curve is exaggerated as the result of extensive destruction of the bodies of the 8th and 9th dorsal vertebræ by tuberculous disease. The remains of these two bodies have fallen together anteriorly, so that together they form a wedge, in the posterior broader end of which a small fragment of the intervertebral disk still remains. The anterior part of the disk between the seventh and eighth bodies has also been destroyed. The remains of the eighth and ninth bodies are infiltrated with cheesy material, which is continued forwards into a small abscess-cavity beneath the thickened anterior common ligament, and extending outwards on the right side beyond the line of the heads of the ribs. There is no evidence of any narrowing of the spinal canal.

A separate deposit of caseous material has destroyed the posterior half of the disk between the eleventh and twelfth vertebræ and the adjacent surfaces of the two bones.

5655

478. The lower five dorsal vertebræ with the first lumbar, divided in the median plane. The disk between the two lowest dorsal bodies has been completely destroyed, together with the greater part of the adjacent epiphysial plates. The corresponding surfaces of the bodies, as well as the anterior surface of the upper of the two, have been rendered slightly irregular by ulceration, and the adjacent cancellous tissue appears in the section to be denser and yellower than normal, as if its spaces were filled with caseating granulation-tissue. A small oval abscess-cavity lies on the surfaces of the affected vertebral bodies to the left of the median plane, and communicates freely with the space between them. The spinal canal and its contents appear to be normal.

5768

T. W. E., a male child aged 3 years, was admitted under the care of Mr. Beck on March 30, 1882. There was angular curvature of the spine in the dorsal region and a history of pain in the back for three weeks; a pressure-sore over the prominence had been caused by a



plaster jacket. On April 7 the temperature rose to 103°, with vomiting and squinting. The fever persisted, and on the 13th convulsions occurred. Death took place on April 17.

*Post-mortem examination.*—Tuberculous meningitis about the base of the brain. Miliary tuberculosis of both lungs, and caseous mediastinal glands. Grey granulations on the surface of the liver and spleen; kidneys healthy; numerous small intussusceptions of the small intestine; caseous glands in the mesentery. (Mr. Hill and Mr. Beck's *Case-books*, 1882, vol. ii. p. 135.)

479. The cervical and dorsal parts of a spinal column, with the adjoining portions of the ribs. The bodies of all the upper eight dorsal vertebræ, except the first, have, with the intervertebral disks, been wholly removed by tuberculous disease, and the portions of the column above and below approximated so as to form a sharp curvature with the convexity backwards along the whole extent of the dorsal region. The spinous process forming the summit of the curvature (fifth dorsal) has been bent downwards and flattened, probably by external pressure. The irregular cavity resulting from the destruction of the bodies of the vertebræ is everywhere lined with a soft almost smooth layer of granulation-tissue, in which in two situations small sequestra lie embedded. At the lowest part of the specimen on the right side a broad flattened track (the upper end of a psoas abscess) passes downwards upon the vertebræ from the cavity of the abscess above; the tissues limiting it are much thickened, and the bodies of the vertebræ superficially ulcerated. No bony union of the parts, either in front or behind, has taken place.

4931

480. The vertebræ of the dorsal region, with parts of the ribs. The bodies of the fifth and sixth dorsal vertebræ have been completely, and those of the second, third, fourth, and seventh, in part, destroyed by tuberculous disease. The spine is bent forwards almost to a right angle, but little osseous union of the parts has taken place. On the right side the roots of the spinal nerves have been dissected out; the falling together of the ulcerated parts has led to a diminution in size of the intervertebral foramen opposite the lowest part of the cavity, and the ganglion of the corresponding nerve appears to be slightly compressed.

153

The patient was a girl 22 years of age. The deformity had commenced two or three years before her admission to the hospital. After she had been for some time in the hospital the power of movement in the lower extremities was entirely lost; the sensibility of the skin seemed sometimes quite wanting, at other times it was nearly perfect. An abscess pointed in the groin. Most extensive sloughing of the nates occurred, leading to exposure of the trochanters of both the femora and of all the posterior surface of the sacrum.

481. Nine of the dorsal vertebræ. The bodies of three of the upper of them have been in great part destroyed by ulceration; the lower two of these are deeply and unevenly hollowed, their surfaces being intersected with sharply-edged ridges which have become compact in texture; the cancellous spaces within the depressions are, for the most part, closed with osseous substance of the same texture. The highest of the three vertebræ affected is flattened on its left side, and two shallow pits in it are evenly circumscribed, and their lamellæ thickened by the healing process. The fourth and fifth vertebræ are firmly conjoined by a broad sheet of close osseous tissue.

174

482. Eight dorsal vertebræ. The front and left side of the bodies of the 2nd, 3rd, 4th, and 5th have been irregularly hollowed and furrowed by superficial ulceration. Close to the median line, new bone has been produced upon the front of the vertebræ below, chiefly about their contiguous borders, where it forms a series of compact bosses; the bones, however, are not ankylosed.

3194

483. The vertebræ of the dorsal region. All of them have, in varying degrees, been excavated by ulceration. Some of the lower vertebræ present large shallow irregular depressions produced by the confluence of several smaller ones, whilst the higher ones are so deeply pitted as to look as if the greater part of their substance had been punched out so as to leave a widely arched honeycomb-like structure. All

the spaces are smoothly circumscribed, and the cancellous tissue in the lower has healed over so as to be hidden from view; the heads of some of the ribs present similar changes.

Some of the bodies, and a few of the articular processes, of the vertebræ have become continuous by ankylosis. The column is curved slightly forwards.

484. The greater number of the dorsal with the upper lumbar vertebræ of a child. The bodies of several of the dorsal vertebræ have been completely destroyed by tuberculous disease, the spinal canal being opened for about 3 cm. of its length, and the cord, covered by its membranes, exposed. The portions of the column above and below have become in some measure approximated, and the spine is bent sharply forwards, giving rise to considerable prominence in the dorsal region. In the situation of the parts which have been destroyed there remains a very irregular cavity, in places sacculated, and lined throughout with a smooth soft membrane of granulation-tissue. Below the main cavity, but continuous with it, is a second considerably smaller cavity, which has resulted from the partial destruction of a single body, the remains of which are still in process of ulceration; the cancellous tissue, which is here exposed by removal of the granulation-layer which covered it, has an uneven pitted surface, and its spaces are widely open. The soft parts on the front of the spine are thickened and inseparably blended together by inflammatory exudation. At the highest part of the preparation there is, on either side, the irregular opening of a track leading apparently to the cavity below, and resulting from ulceration of the bodies of the vertebræ in this situation. 3757

485. The skeleton of the trunk, with the upper ends of the femora, the spinal column being bent forwards to a right angle in consequence of disease, which has at some time destroyed the bodies of the ninth and tenth, with the adjoining parts of the bodies of the eighth and eleventh, dorsal vertebræ; between the remains of the latter two vertebræ firm osseous union has taken place. As a result of the deformity noticed, the ribs are directed vertically downwards, and the base of the thorax is turned backwards towards the front of the lower part of the spine; the greater part of the contents of the abdomen must thus have been displaced downwards and forwards. 173

486. Plaster cast of the head and upper part of the trunk of a boy, showing an extreme angular curvature backwards resulting from caries of the dorsal vertebræ. The resulting deformity of the chest has caused the shoulders to be thrown forwards and the scapulæ to be tilted, so that their dorsal surfaces look considerably upwards. The falling of the upper part of the spinal column downwards has caused a marked sinking of the head between the shoulders. The lower end of the sternum projects forwards and the sides of the chest are flattened.

487. The lower five dorsal with the lumbar vertebræ and sacrum. Ulceration has destroyed almost the whole of the bodies of the last two dorsal vertebræ and the greater part of those next above and below them. The excavated surfaces are smooth, and their cancellous tissue is almost closed. The articular processes of the eleventh and twelfth dorsal vertebræ have become ankylosed. 3134

488. The upper three of the lumbar, with the lower eight of the dorsal vertebræ. About its middle the spinal column is bent acutely forwards after such extensive destruction of the bodies of all the vertebræ except the fifth and sixth dorsal and the second and third lumbar, that the aggregate of their remains occupies a space scarcely equal to that of the two sound vertebræ below them. The parts, closely pressed together, are firmly united so as to form an irregular mass of osseous substance, and the arches and articular processes spread over the summit of the curve are ankylosed; the spinal canal is throughout of natural size.



489. The third and fourth lumbar vertebræ, with those parts of the first and second lumbar and of the five adjoining dorsal vertebræ which have escaped the ulceration by which the rest of their substance has been destroyed. The approximation of the parts has led to an acute angular bending of the column. The portions remaining of the bodies of the vertebræ noticed, as well as their arches and articular processes, are firmly ankylosed, their union being strengthened by new bone filling the irregularities which have resulted from the ulceration. The spinal canal, though abruptly curved in correspondence with the altered column, preserves its natural diameters. The spines of the vertebræ over the summit of the curvature are stunted, flattened, and have almost disappeared from pressure externally applied. 4979

490. A spinal column, together with some of the ribs and the sternum, the former bent sharply forwards opposite the junction of its lumbar and dorsal parts, owing to destruction (in some complete, in others partial) of the bodies of the vertebræ. The bodies of the dorsal vertebræ above, as high as the first, are also superficially ulcerated. The intervertebral disks have been almost entirely destroyed commensurately with the ulceration of the bones. No union of the parts by bone has occurred, except between the articular processes of the 11th and 12th vertebræ. 3064

✓ 491. The dorso-lumbar region of a spinal column, in median section. In the middle of its length the column is bent to an angle of about  $120^\circ$ , as the result of extensive destruction of the bodies of the vertebræ. The body of the 11th dorsal is destroyed along its posterior surface; that of the 12th dorsal along its posterior surface and in its anterior and inferior part. Small portions only of the first three lumbar remain, and the body of the 4th lumbar is irregularly excavated in its upper half. The spinal canal is not encroached upon. Several small loose sequestra lie in the right end of the cavity resulting from the destruction of the vertebral bodies, and from the cavity an opening communicates with the upper end of a psoas abscess on the right side. Opposite the level of the curvature the aorta is greatly puckered. There is no evidence of repair of the disease. 5462

G. C., an anæmic emaciated boy aged  $14\frac{1}{2}$ , was admitted under the care of Mr. Marshall, Aug. 10, 1878. There was angular curvature of the spine from the 9th dorsal to the 5th lumbar vertebra. A psoas abscess on each side was aspirated and afterwards drained. In October the patient was sent to Eastbourne, but readmitted in the following month. The loss of flesh increased; there was persistent irregular fever and bed-sores. Death occurred on January 25, 1879. The lower part of each lung was consolidated, and the pleura covered with recent inflammatory exudation. There was no evidence of lardaceous disease. The psoas abscess on the left side had opened into the hip-joint. (Mr. Marshall's *Case-book*, 1879, vol. ii. p. 41.)

492. The lower part of a spinal column and the right hip-bone, together with the bladder and rectum distended and dried, and the lower part of the aorta and its branches injected. In the dorso-lumbar region of the spine there is an extreme bending forward of the column, resulting from destruction of the bodies of several of the vertebræ. As a result of the spinal curvature the aorta, which is held back to the column by the lumbar arteries, is bent so as to present a very marked loop directed forwards. From the most prominent part of the loop the celiac axis and superior mesenteric artery take their origin. 3071

✓ 493. All the dorsal and the upper three lumbar vertebræ, together with parts of all the ribs of the right side, the spinal canal being opened by the removal of the arches from the left side. As the result of extensive loss of substance in the bodies of the lower dorsal vertebræ, the upper and lower parts of the column have become approximated so as to form an angle of  $50^\circ$  with each other, the most prominent part of the curve posteriorly being formed by the 8th and 9th dorsal spinous processes. The position of the vertebral bodies which have suffered destruction is occupied by the consolidated remains of an abscess which, as the result of the curvature, has been completely folded upon itself. The extension of the abscess

backwards into the spinal canal is still evidenced by the presence of a considerable mass of dense cheesy and calcareous material over which the cord is displaced backwards and the anterior part of the theca thickened and adherent. On the right side the abscess bulged into the lower part of the right pleural cavity, in which position dense adhesions existed and a small piece of the adherent lung still remains. The ribs are closely crowded together as the result of the spinal deformity. 6427

C. C., a girl, was first brought to U. C. II. in 1875 or 1876 when 6 or 7 years of age; a spinous process in the middle dorsal region had been prominent since 1874, but there were no signs of active disease. Two or three years later there was rapid increase of the deformity with much pain; a plaster jacket was worn for more than a year, and other supports subsequently. In April 1881 a chronic abscess in the left buttock was opened and drained; it appeared to have no connection with bone or the interior of the pelvis; it healed in 6 weeks. On September 1, 1882, the patient was readmitted with complete loss of power and loss of sensation in the lower limbs, and loss of control of the bladder and rectum; the plantar reflex was slight, the gluteal and lower abdominal reflexes absent; knee-jerk absent; ankle-elonius present on admission, but soon disappeared. After rest in bed and faradisation of the paralysed muscles some improvement occurred in 6 weeks, and in 3 months the patient could walk with crutches. The recovery of power gradually became complete, and the general health remained good. In December 1888 the patient died of bronchitis, the fatal result being largely due to the impaired respiratory power caused by the deformity of the chest. (*The Illustrated Medical News*, 1889, vol. v. p. 193.)

494. Part of a spinal column, with the neighbouring soft parts, bent forwards in consequence of tuberculous disease of the bodies of the lower dorsal vertebræ; on either side there is an abscess in the psoas muscle, the anterior fibres of which lie upon the front of the sac. The abscesses lead from the seat of disease almost symmetrically downwards by the sides of the lumbar portion of the column. 5064

495. The lower part of a spinal column with the left hip-bone and part of the femur. The spinal column is doubled forwards in the lumbar region in consequence of almost complete destruction of the bodies of the vertebræ in this situation; the lower dorsal vertebræ have also been affected, though in a less degree, whilst the upper segments of the sacrum are greatly diminished in size, and the sacral foramina commensurately enlarged by the ulcerating process; the disease of all these parts is continuous. From the ulcerating bodies of the lumbar vertebræ an abscess leads by a double neck into a pyriform sac lying along the brim of the pelvis, with the external iliac vessels resting on its inner side. In its passage beneath the outer part of Poupart's ligament, the sac becomes contracted, and remains narrowed for about 5 cm.; over this narrowed portion the femoral vessels have crossed. The abscess appears subsequently to have followed the course of the profunda artery and passed inwards beneath the adductor longus; here it rapidly enlarges and reaches more than halfway down the inner side of the thigh. This expanded part of the sac would thus be in contact posteriorly with the adductor magnus and internally with the gracilis, the profunda artery lying between the sac and the bone. Corresponding in situation with the disease of the sacrum is a second smaller abscess communicating above with the cavity from which the abscess first described proceeds. The smaller abscess is oval in shape and extends downwards to the fifth sacral vertebra, being, unlike the other, confined to the seat of the diseased bone. Lastly, the bodies of the fifth to the ninth dorsal vertebræ have been laid bare by the separation of the structures lying upon them, but are themselves without any trace of disease; the intervertebral cartilages between them have been completely destroyed.

This condition has resulted probably from the maceration of the parts in decomposing pus shortly before death, the pus having burrowed upwards beneath the anterior common ligament.

An independent abscess-cavity lies over the upper part of the dorsal surface of the ilium. 5268



496. Four lumbar vertebræ, with the sacrum, left hip-bone, and part of the left femur, and the sac of a large abscess which passed downwards from the upper part of the lumbar region (where portions of the vertebræ shown have been destroyed by ulceration) in the course of the psoas muscle. The abscess extends beneath the situation of Poupart's ligament over the brim of the pelvis, in a direction towards the small trochanter. The bodies of the third and fourth lumbar vertebræ are superficially ulcerated on their anterior surfaces. 175
497. The last two dorsal with the upper three lumbar vertebræ. The bodies of the first two lumbar vertebræ have in great part been destroyed by tuberculous disease which has involved the intervertebral substance and their corresponding surfaces to an extent not quite so great behind as in front. The resulting surface is very uneven, being hollowed into pits, some shallower than others, and of various sizes; the cancellous tissue thus brought into view is everywhere open and light, and shows none of the signs of repair. The column is bent slightly forwards opposite the seat of disease. The displacement causes a marked curve backwards in the line of the spinous processes, the spinous process of the first lumbar vertebra forming the most prominent point of the curvature. 3089
498. The lumbar and last dorsal vertebræ. The corresponding parts of the bodies of the second and third lumbar, together with the intervertebral disk, have been destroyed by caries. The loss of substance is more marked in the upper of the two vertebræ, and in both of them the ulcerated surfaces show signs of healing, the spaces of the cancellous tissue being narrowed or partially closed by thickening of the lamellæ forming them. 3282
499. The bodies of three lumbar vertebræ, together with the cauda equina, in median section. The adjacent surfaces of the upper two bodies have in their central part been eroded by tuberculous disease, the corresponding part of the intervertebral disk being softened and partly destroyed. A small portion of the compact surface of the highest vertebra has separated as a sequestrum, whilst the corresponding part of the surface of the second body is undermined and in process of separation. In the centre of the disk between the lower two vertebræ is a yellowish deposit of soft granulation-tissue, the adjacent bones presenting a perfectly normal appearance in the plane of the section. The inner surface of the dura mater is covered with a thin layer of inflammatory exudation. The focus of disease between the upper two vertebræ is directly continuous with a psoas abscess on the left side, the position of which is indicated by an irregular layer of granulation-tissue on the surface of the bones. 6874
500. The lower four lumbar vertebræ. On their anterior aspect the bodies of the vertebræ have been excavated in varying degrees by ulceration, in some situations very deeply. The body of the fourth is quite riddled with tracks, and the upper border of the pedicle of its arch on the right side has been destroyed. Around the deep pits caused by the disease leaf-like and nodular processes of new bone have been formed.  
The bodies of the third and fourth lumbar vertebræ, and their articular processes on the right side, are ankylosed. 3285
501. Three lumbar vertebræ conjoined into a single mass in consequence of ulceration occurring at several parts of their surfaces, which has been followed by abundant formation of new bone running in irregular spreading masses over them.  
The articular processes on the right side are ankylosed.
502. The vertebræ of the lumbar, together with the last of the dorsal, region. The adjacent parts of the second and third lumbar have been destroyed, and present an irregular cancellated surface, in consequence of tuberculous disease. The front of the body of the fourth lumbar vertebra has also been made uneven by the same

ulcerative process; nodules of new bone have, in places, been formed upon the surfaces of the bone in the neighbourhood. The margins of the bodies of the last dorsal and first two lumbar vertebræ on the right side are more porous than natural, and their cancellous tissue has in part been exposed by superficial ulceration. 154

503. The dorsal, lumbar, and sacral parts of a spinal column. The bodies of the seven vertebræ above the sacrum have, with the exception of the last, been almost wholly destroyed by tuberculous disease; and in their former situation there exists a confused heap of bone formed by their shapeless remains, irregularly united together. By the falling together of the parts, the spinal column is much deformed, and is bent forwards almost to a right angle. The articular processes of the first two lumbar vertebræ are ankylosed together and to those of the adjacent vertebræ. 3065

504. The left half of the lower part of the spinal column and pelvis of a female child, together with the contained soft parts. The bodies of all the lumbar vertebræ have been completely destroyed by tuberculous disease with the exception of the first and last, small parts of each of which remain; and into the position originally occupied by those bodies which have disappeared the upper part of the column has been displaced downwards and backwards, so that the remains of the first lumbar vertebra are almost in apposition with those of the last. A considerable mass of dense fibrous tissue occupies the angle between the top of the sacrum and the front of the remaining part of the body of the first lumbar vertebra.

A very large mass of dense caseous material projects from the position of the bone-disease into the spinal canal, displacing the cauda equina backwards and appearing to compress it against the posterior arches. This caseous mass is directly continuous between the remains of the first and fifth lumbar vertebræ with the cavity of an abscess in the substance of the left psoas muscle. The walls of the psoas abscess are thick, and the upper part of the cavity presents a marked constriction; below this the abscess-cavity enlarges and is filled with inspissated caseous matter. The cavity again becomes narrowed at the level of Poupart's ligament, and projects into the thigh immediately outside the femoral artery. The anterior crural nerve is pushed outwards by the abscess.

505. A median section of the lower four lumbar vertebræ and sacrum, with the neighbouring soft parts. The anterior part of the second lumbar vertebra has been destroyed by tuberculous disease; of the body of the fourth no part remains, and a small part only of the body of the third. The two portions of the column have been approximated in a vertical direction, with very little curvature, the spinous processes of the vertebræ named being closely approximated and firmly conjoined by osseous substance; but the bodies of the vertebræ above and below the seat of disease are separated by a distance of 2.5 cm. In this space the dura mater is exposed; it is thickened and adheres firmly to the bones above and below. A detached sequestrum lay in the cavity shown.

506. The other half of the same specimen, dried after maceration, and exhibiting more clearly the parts of the bones which remain.

A small portion of the posterior part of the third lumbar vertebra remains in connection with the pedicle of its arch, and completes the neural ring. Below this, and separated from it by the natural distance, is the pedicle of the fourth lumbar vertebra; but the body of this vertebra has been wholly destroyed, and the ulcerated end of its pedicle has, by the sinking of the column above, come to rest upon a portion of the back of the body of the fifth, to which it has become firmly united, whilst below, and to the outer side of this and traceable from it, is the pedicle of the fifth lumbar vertebra, the intervertebral foramen between which and the upper part of the sacrum retains almost its natural size. The pedicle of the



fourth lumbar vertebra appears to have undergone displacement inwards by rotation, whereby the fourth lumbar nerve has escaped compression in its passage outwards. Osseous substance has been formed in the tissues around the cavity, so as to form for it an incomplete bony wall, by which the bodies of the vertebræ are held continuous; and the strength of the column is further preserved by osseous union of the spinous processes and other contiguous parts behind.

William Severn, aged 14; admitted June 27, 1871; died December 8, 1872.

The patient was admitted for a right psoas abscess in November 1870. After very profuse discharge the abscess gradually contracted to a sinus. Several pieces of bone came away. On his second admission (June 1871) a left lumbar abscess was forming; this was opened June 29. At this time there was a rounded projection of the lumbar spines, but there was no pain on movement or tenderness over the part. The abscess never closed. For a long time fluid could be syringed freely through from the sinus in the lumbar region to that in the opposite groin. Lardaceous degeneration of the liver and kidneys supervened, and the patient slowly sank and died in December 1872. After death there was found very advanced lardaceous degeneration of the liver, spleen, kidneys, villi of the intestines, &c.; the liver weighed 118½ ounces.

In the cavity in front of the bodies of the lumbar vertebræ there was a detached piece of bone so completely shut in that its escape was impossible. The cavity itself was lined with weak granulations.

507. A sacrum and coccyx with the lower three lumbar vertebræ. The body of the last lumbar vertebra presents, on its left side, two shallow, circular, ulcerated pits placed side by side, and apparently in process of healing, the rods of the exposed cancellous tissue being thickened, and the cavities themselves almost smooth; the adjoining surfaces are thickly covered with branching processes and plates of new bone. A slightly raised, shelving border of bone is present on each side of the first piece of the sacrum. It extends round the inner margin of the first sacral foramen and is continued from side to side across the front of the second sacral vertebra. This bony ridge evidently marks the outline of an abscess in this position.

3088

An abscess communicating with the seat of disease pointed at the upper part of the thigh. The patient died a fortnight after this was opened, from violent "constitutional disturbance."

508. A sacrum with the last lumbar vertebra and the posterior parts of the two hip-bones. The disc between the last lumbar vertebra and the sacrum has been completely destroyed, and the corresponding bony surfaces eroded by tuberculous disease. Irregular deposits of new bone are present on the last lumbar vertebra and on the front of the sacrum. These have probably resulted from the presence of a chronic abscess in this situation. The abscess appears to have extended into the right iliac fossa, where two small patches of felt-like bone have been formed.

6750

509. Part of a spinal column, with the pelvis, of a female. The terminal segment of the sacrum has been wholly destroyed by ulceration, and there are other distinct seats of ulceration on the left side of the body of the third lumbar vertebra and in the lower part of the dorsal region; in the latter situation the bodies of the ninth and tenth vertebræ have been in great part destroyed.

#### TUBERCULOUS DISEASE OF THE STERNUM AND RIBS.

Tuberculous disease may occur in any part of the sternum and lead to extensive loss of substance from caries with or without the separation of sequestra (510, 511). The resulting chronic abscess is superficial if the anterior surface of the bone is affected, but if, as not uncommonly happens, the disease begins on the posterior aspect, a considerable collection of pus may form behind the sternum and find its way to the surface through an intercostal space, above the manubrium, or by perforating the bone.

Tuberculous disease of the ribs and rib-cartilages is common and usually begins beneath the periosteum or perichondrium. It may result in superficial caries (512), complete destruction of the bone in its whole thickness (513), or in the separation of sequestra. The disease often attacks the deep surface of the ribs, so that the resulting abscess is at first situated between them and the pleura, and only later points through an intercostal space. Disease of the vertebral extremity of a rib may result from extension from the spinal column (512).

510. The sternum with the costal cartilages and the inner ends of the clavicles. Both surfaces of the manubrium have been irregularly pitted by ulceration. In its right half considerable loss of substance has occurred and a mass of the cancellous tissue, brownish black in colour, has necrosed, but its separation from the rest of the bone has not yet far advanced. Between the second and third costal cartilages of the right side the body of the sternum is semicircularly notched (as if trephined) in consequence of ulceration with probably the separation of a sequestrum; the surface of the notch is smoothly healed. Broad plates of close osseous tissue overlie the anterior surface of the sternum, and bone of a similar compact texture has been formed also upon its posterior aspect and on the front of the adjoining parts of the costal cartilages. The articular portion of the right clavicle, with part of the under surface, has been destroyed by ulceration. 167

There was an extensive ulcer over the diseased part. The patient, who was "scrofulous," died of dropsy.

511. A sternum, the right border of the body of which has been irregularly ulcerated from midway between the attachments of the second and third costal cartilages downwards as far as the upper border of the attachment of the sixth. The loss of substance is most marked at the level of the attachment of the fourth costal cartilage, where a deep notch extends almost to the middle line of the bone. The disease appears everywhere to have been extending, the open structure of the cancellous tissue being fully exposed to view. Around the diseased area new bone has been deposited on both surfaces of the sternum partly in the form of fine lines and partly as irregular osteophytes. A deposit of new bone covers both surfaces of the upper part of the xiphoid cartilage. 5003

512. The vertebral end of a rib, all parts of which, but especially the inner surface, have been superficially ulcerated as the result of tuberculous disease. The articular surfaces of the head and tubercle have been in large part destroyed. 7906

A. J., a boy aged 16, was admitted into U. C. H. under the care of Mr. Godlee, July 7, 1897. There had been symptoms of disease of the upper part of the spine with abscess for over 18 months. On admission there was slight curvature in the upper dorsal region and a sinus to the left of the middle line on a level with the fourth dorsal spinous process. The sinus was enlarged and the piece of rib preserved in the specimen was removed. Patient left the Hospital on September 4, wearing a double Thomas's splint with head-support; sinus not closed. (Mr. Godlee's *Case-books*, vol. i. 1897, p. 100.)

513. A piece of a rib 4.5 cm. in length, removed for tuberculous disease. In the middle of its length a rounded perforation is present, and below this is a smaller oval perforation nearly closed by a thin layer of soft tissue. The disease is most extensive on the inner surface of the rib, where at the lower end the section does not appear to have been made beyond its limits. 7578

#### TUBERCULOUS DISEASE OF THE BONES OF THE UPPER LIMB.

Tuberculous disease of the bones of the upper limb is chiefly met with in their articular extremities, usually in association with disease of the joints themselves (see Tuberculous Disease of the Joints). The bones of the carpus are frequently affected, sometimes in association with disease of the wrist-joint.



Tuberculous disease of the metacarpal bones and phalanges (tuberculous dactylitis) is very common in young children. The phalanges of the first row are most commonly affected (518, 519). The disease usually begins centrally and leads to fusiform enlargement of the bone (521). Should suppuration occur the pus perforates the bone and forms a superficial abscess on one or both sides of the finger (519, 520). Sequestra are common (521). The joints usually escape (519).

514. A right scapula, in which much of the spine and the posterior border of the adjacent part of the blade have been destroyed by ulceration. A layer of osseous tissue has been formed upon the surface of the surrounding bone, and in some situations has become quite dense like the scapula itself. The greater part of the ulcerated surface is also coated with new bone, which accurately follows its irregularities, and is in parts very close-textured or even compact. On the spinous process the ulcerated surface shows no sign of healing, its cancellous tissue being exposed and deeply and irregularly pitted. 3038

515. The lower part of a right humerus, the shaft of which, in the upper part of the specimen, is diminished in size and irregular in shape in consequence of its partial destruction by ulceration. Its upper end is obliquely perforated, and along the course of a second perforation the portion of the humerus shown appears to have been broken from the rest. In the lower end the inflammation has implicated the deeper parts, and led to an enlargement of this part of the shaft; the compact tissue has been destroyed, and the surface is everywhere cancellous; many deep ulcerated pits pass from behind towards the interior, and one of them leads completely through the bone. In their general aspect the parts appear to be in process of healing.

The articular surface is unaffected.

2891

516. A left radius and ulna. The shaft of the ulna from end to end presents a series of shallow, oval, and circular depressions, the result of superficial ulceration; at the site of these, in three or four places, the shaft is perforated. The cancellous tissue, which has been exposed over almost the whole extent of the bone, is becoming more close in texture by thickening and coalescence of its rods and lamellæ, and the ulcerating process appears to have ceased. The shaft of the radius is very porous along its inner aspect, and its surface undulating, from ulceration. Both the bones are light and wasted. The upper articular surface of each bone is pitted and rarefied. 3215

517. Five sequestra, which were removed from an os magnum; one of them includes the chief part of the articular surface of its head. 2909

518. A wax model of a child's hand, in which the first phalanges of the index and two adjoining fingers were the seats of tuberculous disease. The shafts of the affected bones are considerably increased in size, most at their middle, so as to give to the parts a fusiform figure. Some of the metacarpal bones appear also to have been affected. There was a deposit of tubercle in the skin. 4349

519. A right index finger in vertical section, showing tuberculous disease of the first phalanx. The proximal half of the phalanx is thickened and the epiphysis healthy. The distal half of the shaft is superficially eroded and surrounded by granulation-tissue; although still in continuity with the proximal part of the shaft, it is probably necrosed and eventually would have separated as a sequestrum. The cartilaginous head of the phalanx is separated, but the joint between the first two phalanges appears to be healthy. The soft parts covering the bone are thickened, and opposite the middle of the diseased phalanx there is an ulcer in the skin. 6456

The finger was removed from a female child aged 2½. The finger had been swollen for two months, and abscesses had been opened four weeks before admission. The paternal grandmother died of "consumption." (Mr. Beck's *Case-books*, 1889, vol. ii. p. 165.)

**520.** A middle finger in sagittal section, showing tuberculous disease of the first phalanx. The bone is enlarged and the osseous tissue of its distal half is entirely replaced by soft granulation-tissue, which has also invaded the substance of the proximal half. On the dorsal surface of the bone above the head the periosteum has been destroyed, and a considerable mass of caseous material occupies the soft parts and is continuous with a thin layer of granulation-tissue in the first inter-phalangeal joint. The cartilage covering the head of the first phalanx is intact, and the epiphysis at the proximal end is normal. The soft parts surrounding the diseased bone are greatly thickened, so as to form a globular swelling of the finger. On one side of the finger a caseous mass is exposed in two irregular openings in the skin, and on the opposite side a similar caseous mass is on the point of bursting through the skin. 7087

The finger was removed from a boy 12 years of age. An abscess following a blow had been opened six months previously. There was no family history of phthisis.

**521.** The phalanges of a finger, from a young subject, the first phalanx being much expanded, in consequence of tuberculous disease associated with necrosis of part of the cancellous tissue. There is a large oval aperture in one of its sides, and a second smaller one in its anterior wall. The small sequestrum shown lay within the cavity in its interior. Neither of the joints in connection with the diseased phalanx appears to have been affected. 5131

**522.** The phalanges of a child's finger. The first phalanx is greatly enlarged as the result of chronic inflammation. New bone has been thrown out by the periosteum. The proximal end of the bone has been destroyed, and the exposed cancellous tissue appears to be in a state of necrosis. 2955

#### TUBERCULOUS DISEASE OF THE BONES OF THE LOWER LIMB.

In addition to the very frequent occurrence of tuberculous deposits in the articular extremities of the bones of the lower limb in association with joint-disease, tuberculous disease may also occur in various parts of the bones independently of any articular affection. Thus, tuberculous caries and necrosis are not uncommon in different parts of the hip-bone (523, 524), in the great trochanter (525, 526), in the lower extremity of the femur (528), and in the upper extremity of the tibia (530). The disease is also very common in the tarsus, especially in the os calcis, astragalus, and navicular (532, 533, 534). Disease of the astragalus is of especial importance, in consequence of its liability to infect the ankle-joint, whilst in the case of the navicular the disease is especially apt to extend to the neighbouring bones by way of the large synovial sac in front of the bone. Of the metatarsal bones the first is most frequently affected (535); the phalanges may be affected in a manner similar to, but with much less frequency than, the phalanges of the fingers.

**523.** A right hip-bone, the iliac portion of which is in two places perforated by ulceration. The anterior of the perforations, situated near the anterior superior iliac spine, is circular and 1 cm. in diameter; its edges are rounded, smooth, and evidently in process of healing. The posterior and larger perforation is below the middle of the crest of the ilium; it is oval in shape, 2.5 cm. in its longer diameter, and its edges are rough and irregular, as if the disease were still in active progress. The anterior inferior spine of the ilium has also been partly destroyed by ulceration; the superior has been made irregular by osseous deposit. New bone has been thrown out irregularly on the outer surface of the ilium around the perforations, and in the neighbourhood of the larger one the



iliac crest is superficially ulcerated. A thin layer of new bone covers almost the whole surface of the iliac fossa. It is probable that an abscess lay beneath the iliacus muscle, and that the discharges escaped by the openings described above. 4751

**524.** A left hip-bone. The tuberosity of the ischium has been in great part destroyed, and its remains deeply hollowed, in consequence, probably, of tuberculous disease attended with the separation of sequestra. Irregular pointed masses of new bone have been formed along the outer border of the cavity resulting; the centre of the latter is bridged across, and the surface of the hollow is smooth as the result of the healing process. An irregular deposit of new bone covers the outer surface of the conjoined rami of the ischium and pubic bone and the body of the latter. 391

**525.** The upper end of a left femur. The anterior half of the great trochanter has been almost wholly destroyed by ulceration, which has spread within and hollowed out its interior. On the posterior aspect of the ulcerated cavity an oval portion of the cancellous tissue has been deeply undermined; it was probably in a state of necrosis. A deposit of new bone extends from the great trochanter to the upper part of the linea aspera. 3143

**526.** The upper end of a right femur. The great trochanter presents, on its outer surface, a deep pit, within which it is probable that a portion of the cancellous tissue lay, having been separated after necrosis. The surrounding surface is made prominent and uneven by a deposit of new bone, which inferiorly has taken the form of pendent leaf-like processes. New bone has been thrown out along the anterior intertrochanteric line. 3705

**527.** Two sequestra, separated from a great trochanter as the result of tuberculous disease. Prior to the death and separation of the bone the thin compact layer covering the surface of the lower sequestrum has been destroyed, and the cancellous tissue exposed by ulceration. 3109

The sequestra were removed from an abscess in a patient who died of phthisis.

**528.** The lower half of a left femur, with the upper ends of the bones of the leg and the patella, of a child 9 years old. The lower end of the shaft of the femur is widely enlarged and club-shaped, in consequence, probably, of the inflammation maintained by the presence of a sequestrum of the cancellous tissue, which lies detached within an extensive cavity in the enlarged part of the bone. Wide-spread sup-puration has apparently ensued around the necrosed portion, the abscess opening inferiorly by a large aperture between the condyles into the knee-joint, and by two considerably smaller ones situated near the upper end of the enlargement, on the outer and posterior aspects; the larger of these two openings is about 5 mm. in diameter. A branching plate of new bone attached in part to the shaft, but in part overhanging its surface (showing it to have been produced from the periosteum here separated), has been formed on each side. 3650

When the patient was admitted to the hospital the lower two-thirds of the thigh were enlarged, hard, and inelastic, with sinuses extending to the bone; the knee was bent, but capable of slight movement. Four years previously the patient received a blow on the knee; the part swelled, but it was not painful, and the child was able to run about for a year afterwards.

**529.** The lower half of the shaft of the left femur of a child, its lower extremity widely expanded and rarefied in consequence of inflammation affecting its substance. On the outer side, where the swelling exceeds that on the inner, the femur presents a deep excavation, resulting from a chronic abscess, bridged over only by a narrow strip of the wall remaining. The cancellous tissue, which has thus been opened, is for the most part closed by a thin limiting layer of new

bone. The shaft above is half ensheathed on the same side by an even layer of minutely porous new bone. 1348

530. The upper end of a right tibia, the chief part of the cancellous tissue of the head of which has undergone necrosis, and lies loosely enclosed within the compact wall, after having been completely separated from the living tissue with which it was once continuous. Two cloacæ, more or less circular in shape, and each about 1 cm. in diameter, have been formed in the enclosing wall; one of these is situated upon the inner, the other upon the posterior aspect of the bone; the surface around them is covered with osteophytes. 2913

531. The lower end of a fibula with one of the cuneiform bones, the former deeply pitted by ulceration; the cuneiform bone is in part covered by long bony processes, and on one of its surfaces is ulcerated. 2934

532. A right os calcis and astragalus, together with the cuboid and navicular bones. The posterior surface of the os calcis presents a broad vertical furrow, the surface of which is in most parts smooth and healing. From this furrow two deep pits extend into the bone, and have probably resulted from the separation of sequestra of the cancellous tissue. The rest of the os calcis is covered with dense new bone, the astragalar articular surfaces are extensively destroyed, and the front of the bone is ankylosed to the remains of the cuboid. The upper part of the astragalus has also been irregularly and deeply excavated by ulceration, combined perhaps with necrosis, and its head has become ankylosed to the navicular after destructive inflammation of the joint between them. The cuboid and navicular bones are also united, and their anterior articular surfaces have been extensively destroyed by ulceration.

533. A left os calcis, its upper portion being wanting. The whole bone has been extensively and irregularly excavated by tuberculous disease, the large cavity within it being incompletely divided into an anterior and a posterior part by a septum, which is itself deeply pitted and channelled by ulceration. In the outer wall of the shell remaining there is an oval cloaca 1.5 cm. in length, with smooth edges, and by which the anterior of the cavities opens on the exterior; the posterior cavity appears to have been widely open superiorly, the edges of the aperture being also smoothly rounded; little new osseous tissue has been formed on the surfaces around. The cancellous tissue exposed within the cavities appears for the most part to have been in process of healing. A sequestrum probably lay in each of the cavities described. 4207

The parts shown were successfully removed by operation. The os calcis and astragalus were ankylosed.

534. The remains of a navicular bone which has undergone necrosis, probably as the result of tuberculous disease. The sequestrum includes portions of both the articular surfaces, and the bone has been extensively destroyed by the ulceration which preceded its death. 2918

535. The metatarsal bone and phalanges of a great toe. The metatarsal bone is greatly enlarged, partly by a thin layer of finely porous bone which has been formed upon it, but chiefly by inflammatory expansion of its texture. Near its base an irregular cavity has been made in the expanded wall by ulceration. 1213

536. The phalanges, with the head of the metatarsal bone and the sesamoid bones, of a great toe. The first phalanx is much increased in size, partly by a deposit of new bone upon its surface, partly by "expansion" of its substance; on one side towards the proximal extremity it appears to have been carious for an extent marked by a circular ulcerated aperture in the new bony layer. The



metatarsal bone has become extremely light and porous, and its compact tissue thin, from atrophy. The sesamoid bones are slightly enlarged. 2948

537. The phalanges and distal end of the metatarsal bone of a great toe. The corresponding articular parts of the metatarsal bone and first phalanx have been destroyed by ulceration. A portion of the cancellous tissue of the metatarsal bone has undergone necrosis, and lies between the two bones, the surfaces of which have for the most part smoothly healed. 2946

The toe was removed by amputation.

### SYPHILITIC DISEASE OF BONE.

The effects of syphilis on the bones are in all essential respects similar to those produced by the disease in the soft tissues, and the changes resulting are in detail of the same kind as those due to chronic inflammation of the osseous tissue arising from other causes.

The most simple, and as a rule the earliest, affection of bone which results from syphilis is periostitis, indistinguishable from simple inflammation; it is usually limited to the most superficial parts of the long bones. The inflammatory products may be completely absorbed, or they may ossify, leaving a slightly flattened mass of new bone (Syphilitic Node) (547) or a fusiform enlargement of the shaft (541). Nodes are common on the outer surface of the flat bones of the skull; they may also form on the inner surface (595). In a section through such a node the new bone is usually easily distinguishable from the old by its more spongy texture. The old bone, if the node is of recent origin, will show signs of having shared in the inflammation, its Haversian canals being slightly enlarged (541). In very old nodes the new bone becomes inseparably blended with the old, and exactly resembles it in structure (543).

The later or tertiary effects of syphilis are characterized briefly by:—(1) diffuse chronic inflammation of all parts of the bone; (2) the formation of syphilitic gummata. These either occur singly or together.

(1) *Diffuse chronic inflammation*, as it affects the periosteum, is characterized by the formation of new bone, layer by layer, so as greatly to increase the size of the affected bone (562). At the same time the compact tissue becomes at first more spongy than natural from exudation into the Haversian canals and slight destruction of their bony walls. In the medullary canal it is not uncommon to find new spongy bone (556, 557). In a later stage the new tissue often becomes of intense density by the gradual deposit of bone, layer by layer, upon the walls of the canals for the vessels (Syphilitic Sclerosis of Bone) (545, 555). The effects of this diffuse chronic inflammation are best seen in the skull (599).

(2) *The formation of gummata*.—A gumma is a gelatinous mass of fibrous and cellular elements, but slightly vascularized, and tending, unless relieved by treatment, to soften and to point to the surface like an abscess. Gummata of bone form most commonly under the periosteum (576), but they may also be met with in the medulla (565). By the extension of the gummatous growth the subjacent bone is eroded by a process exactly analogous to simple ulceration. This erosion may involve the surface of the compact bone (553) or the surface of a previously-formed osseous node (552). When the gumma softens and discharges on the surface of the skin the eroded patch is left bare and constitutes what is known as Syphilitic Caries (574, 575). The loss of substance in the bone caused by the gumma may thus be increased as the result of simple septic inflammation. When healing occurs the ulcerated surface of the bone becomes smooth and compact (577), and it not uncommonly happens that a considerable deposit of new osseous tissue occurs in the base of the ulcer over the bone which resulted from the breaking-

down of the gumma (558). These changes produced by gummata are best seen on the bones of the skull. No. 576 shows unsoftened gummata, many of which have perforated the skull; Nos. 574 and 575 show the effects of gummata in causing perforation or deep ulceration of the bones of the skull. Occasionally the formation of the gumma takes place between the dura mater and the bone.

Caries following the formation of subperiosteal gummata is one of the most common of the later effects of syphilis on the long bones of the limbs; it chiefly affects the shaft, but in rare instances a joint may be invaded by perforation of the articular extremity (561).

Subperiosteal gummata are also frequently followed, especially in the cranial vault, by more or less extensive death of the subjacent bone (Syphilitic Necrosis) (600, 601). The necrosis is caused in part by the separation of the periosteum by the gumma; in part by the sclerosis of the bone leading to complete obliteration of many of the Haversian canals; and in part by the septic inflammation of the bone which is apt to follow the softening and discharge of the gumma on the surface of the skin.

As a result of the chronic inflammatory changes which preceded its death, the syphilitic sequestrum is often very dense and covered with nodules of new bone, or its surface may be pitted by ulceration (601). In this respect it differs markedly from the sequestrum produced by injury or acute suppuration (compare 397 and 89). The separation of a syphilitic sequestrum is usually very slow.

Caries and necrosis may also result from the invasion of a superficial bone by a gumma beginning under the skin; and similarly, in the bones and cartilages of the nasal cavities, &c., caries or necrosis may follow the formation of gummata in the mucous membrane over them (594).

A very important feature of the syphilitic inflammations of bone is the great want of uniformity in the pathological changes going on simultaneously. Thus in one specimen we may see rarefactive inflammation, osteoplastic inflammation, with the formation of soft bone and dense ivory-like tissue, ulceration, spreading on one side and healing on another, and necrosis (596, 601). This want of uniformity is especially well seen in the syphilitic affections of the skull. Thus we find the association of various localized lesions—osseous nodes, caries, and necrosis (574 *et seq.*); and in many instances these changes are associated with diffuse thickening and sclerosis of the bones (596 *et seq.*).

*Congenital Syphilis* produces changes in the bones, which, in the later stages, are in most respects similar to those met with in the acquired disease. A form of inflammation is also apt to affect the epiphyses (*syphilitic epiphysitis*) and may be followed by separation of the epiphysis, or rarely by suppuration. In the skull congenital syphilis may produce among the later results gummata with caries or necrosis, and diffuse sclerosis. The most common early change is periostitis with the formation of thickenings chiefly in the position of the eminences and along the margins of the sutures. In macerated specimens thin deposits of new bone are recognizable (603). Cranio-tabes also occurs in syphilitic infants (602).

**538.** A left clavicle, the middle third of the shaft of which presents a low swelling, or *node*, rising almost imperceptibly from the natural surface, and composed of close-textured osseous substance with a smooth, compact exterior, grooved and perforated somewhat more markedly than the healthy bone, the deposit having occurred as a result of syphilitic inflammation of the periosteum and superficial layers of the bone. 1277

**539.** A left clavicle much increased in size by a deposit of new bone, in places with a smooth, close, slightly undulating surface, in others nodulated and minutely porous. The outer half of the posterior part of the clavicle is flattened, and its cancellous tissue exposed by ulceration; the new bone formed around this situation is much more recent than that covering the inner half of the clavicle. 3193



540. A left scapula, in which the acromion process and more superficial part of the spine have been enlarged by the formation upon them of new osseous substance, in consequence, probably, of syphilitic periostitis. The new bone is covered with a thin, compact layer, which is abundantly perforated with apertures of various sizes and shapes, for the transmission of vessels to and from the interior. 3326
541. A right humerus, the lower half of the shaft of which is enlarged by a deposit of new bone on its surface, probably as the result of syphilitic periostitis. In nearly all parts the deposit is more open in texture than the normal compact surface of the shaft. In several places in which the new osseous tissue has been detached, especially along the external supracondylar ridge, the subjacent compact layer is considerably rarefied. Several patches of new bone are present in the upper half of the shaft, the best marked being at the lower end of the bicipital groove.  
From the dissecting-room.
542. The upper end of a right ulna, upon the back of which, a short distance below the olecranon, is a low porous deposit of new bone, rising gradually from the surrounding surface, and formed as a result of syphilitic inflammation of the periosteum and bone immediately subjacent. 2937
543. A left tibia in longitudinal section, upon the middle third of the shaft of which a layer of new osseous substance has been deposited so as to irregularly surround it, in consequence of syphilitic inflammation. The new bone has become of dense compact texture like the wall of the shaft itself, but a faint line (in parts, however, interrupted) marks the limits of the two. Neither the wall itself nor the interior of the tibia is in any way affected. 3113
544. A right tibia, the shaft of which is, for a distance exceeding its middle third, slightly increased in size by a deposit of new bone, which, upon the inner or subcutaneous aspect, has a longitudinally grooved surface, and upon the others has become smooth or covered with broad plates of compact osseous tissue. The texture of the added bone is dense, like that forming the wall of the shaft itself, with which the section shows it to have become indistinguishably blended. 3891
545. A left tibia and fibula, the shaft of the former uniformly enlarged for about its middle two-fourths by a syphilitic deposition of new bone on its surface. Posteriorly, and in a less degree on the outer aspect, the surface of the new bone is smooth and more nearly resembles that of the unaffected parts than in front, where the new bone is deeply grooved and perforated. The section shows the new and the old bone to have become uniformly blended; the compact tissue of the shaft has been inflamed, and is in places more porous than natural. The fibula is quite healthy. 3055
546. A left tibia, upon the front of which there is a long oval node corresponding with the middle third or more of its shaft. The bone presents an unusual curvature forwards which is probably independent of the disease. 3000
547. A left fibula, having a prominent oval node upon its outer surface about 5 cm. below the upper end. There is also a less regular and prominent deposit upon its inner surface at the same level. 1925
548. A right fibula, the shaft of which, towards its lower end, presents a long fusiform enlargement in consequence of the formation of new bone upon it, as a result of syphilitic inflammation.
549. A left fibula, almost the whole length of the shaft of which presents an irregular deposit of new bone, resulting probably from syphilitic periostitis. The deposit is

most abundant along the anterior surface. At a short distance from the lower end one of the bony outgrowths presents a smooth ivory-like surface. 2981

550. A left fibula, the middle third or more of its shaft irregularly enlarged in consequence of syphilitic inflammation; the new bone formed upon it has, for the most part, a close compact exterior like the rest of the shaft.

551. A left tibia in longitudinal section, upon the shaft of which, except at its upper and lower ends, new bone has been formed, as in some of the preceding specimens. Anteriorly the new layer, which is throughout of compact texture, has been pitted, towards its upper part, by ulceration, so as to have a coarse, open, net-like structure. On the anterior part of the inner surface there is an oval circumscribed area slightly raised above the surrounding bone, and having a healing cancellated surface; this probably corresponded with an ulcer of the integument. 3041

552. A right tibia, on the front of which, opposite the middle, there is a slightly raised syphilitic node, the surface of which has been eroded by ulceration. 1313

553. A left tibia presenting changes similar to the preceding, except that they are all of considerably greater extent. The ulceration has penetrated unevenly to the surface of the shaft, and has almost isolated portions of the new osseous tissue, which stand out from the rest, and are encompassed by deep ulcerated grooves. A short distance higher up a small portion of the wall of the tibia, together with the superficial part of the subjacent cancellous tissue, has been destroyed by ulceration, and similar though smaller apertures exist in its posterior wall.

554. The upper half of a right tibia, the inner surface of which is, for a distance of about 8 cm., depressed and very uneven, having been eroded by ulceration, which has most probably commenced in a deposit of new bone upon it, but has almost everywhere exceeded the limits of the latter, and inferiorly has advanced into the unaltered tissue of the shaft.

555. A left tibia in longitudinal section, the shaft of which is, for the greater part of its length, enveloped by a deposit of new bone, the result, probably, of syphilitic inflammation, which has affected its entire substance and led to the partial filling of the medullary canal with osseous tissue.

All the parts are of nearly uniform compact texture, no distinction between them being now recognizable. On its inner aspect the new bone presents numerous close-set shallow depressions and deeper undermining pits, in consequence of destruction of parts of its substance by ulceration. 2998

556. A right tibia, diseased in a manner almost identical with the preceding and probably from the same patient, the two bones being almost symmetrically affected. 2997

557. A right tibia in vertical section. The whole length of the shaft is enlarged as the result of a deposit of new bone on its surface. The surface of the deposit is in most parts smooth and compact, and in section the new bone is indistinguishable from the original compact tissue. A considerable formation of cancellous bone has taken place in the medullary canal. 7282

558. A right tibia. An undulating layer of new bone has been formed upon the middle third or more of its shaft, thickest on the inner and posterior surfaces, in consequence, probably, of syphilitic inflammation. On the inner aspect, towards the lower end of the deposit, is a raised circular area, in its centre composed of firm, curling, yet delicate lamellæ, and formed probably in an ulcer of the integument. 2972



559. The upper half of a right tibia, presenting upon its inner aspect several cup-shaped depressions and deeply spreading pits, in consequence of loss of substance from ulceration, probably syphilitic. The ulceration has passed through a wide-spread deposit of new bone into the subjacent part of the shaft; the osseous substance lining the ulcers is very light, delicately reticular, and friable. Close below the inner condylar surface is a large depression, irregular in outline and surface, which has resulted from ulceration, combined, probably, with necrosis of portions of the exposed and undermined cancellous tissue. 3888
560. A left tibia, on the inner aspect of which, a short distance below the middle, is a deep irregular depression caused by ulceration, which has at certain points penetrated to the interior of the shaft (some of the cancellous tissue within which has also been involved), and has resulted, probably, from syphilitic inflammation. The ulcerated surface is imperfectly covered with a lamina of very delicately cancellated new bone. The lower half of the shaft of the tibia is overlaid with a thin deposit of osseous substance, which has almost everywhere a close or compact surface and extends upwards along the outer aspect of the bone. 5159
561. A left tibia, the wall of which is, for its upper half, perforated in numerous places by large ulcerated apertures of various shapes and sizes, the largest being 4 cm. in length. Considerable parts of the interior of the bone have been destroyed, and on the articular surface are the openings of several winding spaces which communicate with the larger cavity below. The ulcerated surfaces are for the most part lined with a dry crumbling layer of new bone. 5151
562. A right tibia, the shaft of which is almost uniformly enlarged by deposition of new bone, and much increased in weight by condensation of the added osseous tissue. On the inner, subcutaneous, aspect is a series of irregularly circular or oval, shallow depressions, the lowest three of them nearly equal in size, and each about 1.5 cm. in diameter. The surfaces of the depressions are formed by a granulated layer of new bone, the component parts of which are closed with compact tissue; the depressions probably corresponded with long-standing ulcers in the integument.
563. A right tibia, the shaft of which has been increased in size by the formation of new bone upon it and, as a result of inflammation long affecting its substance, converted into a ponderous solid mass by the consolidation of all its parts after filling of the medullary cavity with new bone. Anteriorly, about its middle, the surface is irregularly ulcerated. 5010
564. A tibia, which shows various effects, probably due to syphilitic disease. Upon its middle two-fourths new bone has been accumulated, so as to form a long knobbed or lobed mass, the surface of which has been made still more uneven by ulceration. Above this the tibia presents a long deep notch, due to loss of substance from ulceration, combined perhaps with necrosis. The femur was ankylosed to the tibia by bone, and in forcibly separating the bones fragments of the condyles remained attached to the tibia. The astragalus and tibia have also become ankylosed after considerable destruction of their contiguous parts.  
There is no history to the specimen.
565. A vertical section of the lower part of a right tibia, astragalus, and os calcis, together with the overlying skin of the inner aspect of the limb. The compact tissue of the tibia, with the exception of the most superficial lamellæ, has assumed a widely open cancellous structure, as the result of chronic inflammation. The interior of the bone is occupied by a dense gummatous mass 7 cm. in length; at its centre the gumma is 1 cm. in diameter, and enlarges below, where it

reaches to within 1 cm. of the articular surface. The head of the astragalus has been extensively destroyed by ulceration. The astragalus and os calcis are ankylosed by bone, and their cancellous substance presents numerous small greyish deposits of gummatous tissue. The integument is extensively scarred and ulcerated; in the lower part of the ulcer the carious remains of the head of the astragalus are exposed, and immediately above this an opening leads into the ankle-joint, the cartilage of which is eroded on the astragalus. 5480

S. E., a married woman, aged 48, was admitted, under Mr. Marshall, April 10, 1880. For seven or eight years she had been subject to ulcers on legs and other parts of body. No other evidence of syphilis. Only child died at 6 months of inflammation of lungs; no miscarriages. Ulcer on right leg extended from junction of middle and lower thirds to within  $1\frac{1}{2}$  in. of toes; parts of tarsal and metatarsal bones were exposed in ulcer, and had neeroded. Amputation was performed through middle of leg. Discharged on July 1. (Mr. Marshall's *Case-books*, 1880, vol. ii. p. 261.)

566. A right femur, upon the inner aspect of the shaft of which, and extending over about its middle third, is a long oval swelling rising somewhat abruptly from the surface, having a compact, almost smooth exterior, and deposited as a result of syphilitic inflammation. There are two or three slightly raised deposits of similar dense bone upon the anterior surface, and another ill-defined wide-spread deposit exists on the inner aspect a short distance below that first described. In the situation of the insertion of the lowest part of the adductor magnus a conical mass of bone has grown upon the upper part of the inner condyle. 1327

The other femur from the same patient is preserved as No. 264. It is fractured a short distance below its middle, and shows no signs of repair. The patient died fourteen days after the injury. He was suffering from the effects of mercury at the time. There is no history as to how the bone was broken.

567. A right femur, on the middle third of which, upon its inner aspect, there is a long oval node, very dense in texture, and like the wall of the shaft itself; its surface is irregularly channelled with vascular grooves. 3002

568. A right femur. An oval circumscribed layer of osseous tissue has been deposited upon the middle third of its inner surface, and an elongated irregular mass, about 13 cm. in length, continuous with it, upon its posterior aspect, in consequence, probably, of syphilitic inflammation. The portion last mentioned is obliquely perforated by a large oval channel. 3325

569. The lower part of a right femur, the inner side and front of which present a slight wide-spread enlargement, due to the formation of new bone on it as a result of syphilitic inflammation. The new osseous tissue has a uniformly smooth compact surface. 226

570. A left femur, the inner side of which is enlarged for a distance of about 15 cm. by an oval deposit of uniformly compact new bone, probably a syphilitic node; the anterior surface of the deposit is obliquely furrowed and pierced by large vascular channels, so as to have a fasciculated character. The section shows the compact tissue of the shaft to be unnaturally porous, and the new bone is indistinguishably blended with the old. The medullary canal is slightly diminished in size; the wall of the femur for its upper two-thirds is thicker than natural, but the new osseous tissue has been formed in greatest amount on the inner side in the situation first noticed. 2993

571. A left femur, almost the whole shaft of which is enlarged, and has an uneven sinuous outline in consequence of the deposition of new bone upon it in variously-sized oval and encircling masses, probably as a result of syphilitic inflammation; the wall of the shaft is also less dense than natural, or in places cancellated, showing it to have been involved in the inflammatory process. The great trochanter has been partly destroyed by ulceration. 2995



572. The other femur of the same patient, showing changes which closely coincide both in kind and degree with those in the preceding specimen. 3010

573. A right femur, increased in size and weight by the deposition of bone, probably as the result of syphilis, upon the surface of its shaft, in consequence of long-continued inflammation. The new bone has a compact surface, on the sides almost smooth or slightly undulating, on the front perforated with large vascular channels which run for the most part in an upward and outward direction.

#### SYPHILITIC DISEASE OF THE SKULL.

574. The skull of a young adult, in which extensive changes have occurred from syphilitic disease. The frontal and parietal bones are, over several large irregular areas, pitted and excavated by ulceration, which has in places extended beneath the outer table into the diploë so as to undermine the outer table, the sharply-edged ragged borders of which overhang the ulcerating surface beneath. At certain spots these edges are slightly raised by a line of new bone formed on them in short minute parallel rods, which radiate from the centre of the aperture. At the junction of the basilar process of the occipital bone and the body of the sphenoid there is a deep ulcerated pit, which probably corresponded with an ulcer of the pharynx. Above the external angular process of the frontal bone on the right side is a slightly depressed circular area, the osseous tissue forming the base of which is compact, yet not smooth like the surface of the bone around; in the centre of this is a small irregular smooth-edged aperture, the opening apparently of a more deeply ulcerated space in the diploë. 3240

575. The roof of a skull, perforated in many places by ulceration, which has penetrated its entire thickness without spreading in the lateral direction; around the irregular apertures so made the outer table is superficially ulcerated. Internally in several situations, far removed from the seats of the disease on the exterior, the surface is pierced with small holes, which have coalesced to form much larger irregular gaps in the inner table and diploë, the former of which is, moreover, in some of these situations extensively undermined. Around a perforation above the right orbit healing has occurred, and the bone is smooth. There are two or three ivory-like areas on the parietal bones. 3129

576. The roof of a skull, upon which, in several situations, syphilitic gummata have been formed, by the deep extension of which the bone has in places been completely perforated. The syphilitic growths appear externally as irregular, wide-spread, lowly-raised patches of tough, white, fibroid-looking substance, in the deeper part of some of which osseous substance has been formed. In places the new growth has been removed from the subjacent bone (to which it firmly adheres), the surface of the skull being in these situations ulcerated, as in No. 574. One of the patches is seated in the middle line upon the posterior part of the frontal bone; the others are arranged, with a slight approach to symmetry, round the middle parts of the skull. Upon the inner surface similar, yet more extended, patches exist; but, though more extensive, they nevertheless, for the most part, correspond in position with those situated upon the exterior. The skull itself is of natural thickness and density, nor does either its outer or its inner surface, except where altered by the growths described, present any noteworthy change. In the right half of the frontal bone, near its posterior part, there is an irregular aperture about 2 cm. in diameter, closed with tough fibrous-looking tissue like that existing upon the surface in other parts; the edges of this aperture, where

exposed by separation of the new tissue, are sharp, sinuous, and toothed. On the left side there is shown part of a second perforation, having similar characters but situated more externally and lower than that just described. 3053

577. The roof of a skull, in the middle line of which, and about midway between the ends of the sagittal suture, is an irregular depression with a uniformly compact surface resembling that of the bone around, and resulting, probably, from the healing of a syphilitic ulcer, which has extended inwards in places as far as the internal table. The interior of the skull is unaltered, except in being slightly increased in vascularity opposite the seat of disease. There is another ulcer which has healed near the anterior and upper angle of the left parietal bone; the portion of the suture in its neighbourhood is obliterated. A third almost healed ulcer is situated on the frontal bone above the glabella, and is marked by a smooth shallow depression, the left margin of which presents a worm-eaten appearance. 3267

578. The roof of a skull, showing three separate syphilitic ulcers, in all of which healing appears to have been complete. One, situated near the centre of the frontal bone, appears as an almost circular depression 3 cm. in diameter, with a smooth surface and rounded shelving edges, compact in texture. A second smaller depression occupies the antero-superior angle of the right parietal bone. A third depression, irregularly quadrilateral in outline, lies between the left parietal eminence and the sagittal suture. In the centre of this depression the bone is completely perforated. A thin layer of compact new bone covers the inner surface of the frontal bone.

579. A cranium, in which both the parietal bones, and in a less degree the frontal, are deeply pitted and overrun with branching and undermining furrows, in consequence of syphilitic ulceration. The edges of the portions thus almost isolated are smoothly rounded, and superficially tuberculated by the formation of new bone upon them. The ulcerated surfaces are in some places healed and compact, in others coated with a thin layer of new bone with firm, close, curling lamellæ. In a few situations, as upon the lower part of the frontal bone, and in a few isolated areas near the front of the left parietal, the edges of the ulcers are sharply toothed and overhang the surface beneath, in which ulceration is still advancing. In the deepest parts of the different depressions the ulceration has extended through the entire thickness of the bone, the roof of the skull being extensively perforated and sieve-like. 3239

580. The upper part of a skull. In the lower portion of its left half the frontal bone presents changes similar to the preceding specimen; and each parietal bone is perforated over a small spot in the neighbourhood of its eminence. Thin patches of dense new bone have been formed on the inner surface of the parietal bones along the course of the longitudinal sinus. 3255

581. A skull-cap. The surface of the frontal bone has, in its right half or more, been made rough and coarsely reticular by ulceration, which has extended irregularly through the outer table; the edges of the portions of the outer table which lie between and around the ulcerated parts are smoothly rounded, and their surface tuberculated or undulatory; in a few situations the depressed ulcerated surface is closed with a corresponding thick, uneven, compact layer. On the inner aspect similar changes, but affecting a very much smaller area, exist. Although the diseased patches externally correspond in position with those on the interior, the skull is nowhere perforated. 4950

582. The roof of a skull, on the frontal eminences of which are two ulcers, that on the left extending through the superficial layers of the outer table only, that on the right much larger, and in places reaching the diploë. The border of the



last ulcer is straggling, notched, and slightly undermined; in its centre there is a small irregular portion of the outer table, which remains almost unaltered in aspect, the ulceration having spread annularly round it. The inner table of the frontal bone is nearly covered with a film of firm osseous substance; and similar new bone has been formed on the inner surface of the right parietal bone in the situation of its eminence; beneath the latter spot, as well as beneath the eminences of the frontal bone, the skull is superficially ulcerated. 116

583. The roof of a skull, from the frontal part of which an irregular sequestrum, including in places the inner table, has been detached; the uneven surface from which it has been separated is nearly everywhere smoothly healed, and the sharpness of the overhanging edge of the outer table, except at the upper part, removed; in the situation last mentioned the ulcerating process is apparently still in progress, and has undermined the outer table and a portion of the subjacent diploë so as to have almost isolated the latter. A short distance above the anterior inferior angle of the right parietal bone is a shallow, smoothly rounded excavation, probably the cicatrix left after the absorption of a subperiosteal gumma which has destroyed a portion of the subjacent compact table. The inside of the skull-cap is in places lined with a thin layer of hard new bone; the proper substance of the skull is unaffected. 3355

584. A skull-cap, in which five elongated apertures, the largest about 6 cm. in length, have resulted from ulceration and the removal of portions of the bones after necrosis. The margins of the apertures in the outer table are smoothly healed, as is also an extensive ulcerated surface on the right side of the largest of them. In the middle line an irregular sequestrum of the frontal bone lies detached between the outer and inner tables; the lower end of the necrosed portion corresponds with an ulcerated aperture in the outer table, close above the margin of the orbit; its upper end, with the lower border of the aperture in the middle line next above it. The aperture above the orbit opens into the frontal sinus. 111

The patient was a sailor, who had fallen from a height on his head; he was more than once treated with mercury, but the disease, by competent authority, was not considered syphilitic.

585. The roof of a skull, upon the inner surface of the frontal part of which a thick tuberculated layer of bone has been formed. The new bone does not extend up to the middle line; its limits are well defined, and in some places the border of the deposit slightly overhangs the inner table. The surface of the new bone is distinctly striated in a direction forwards and outwards, conformably with the folds and fibres of the dura mater. There is no general thickening of the skull, but at the middle of the sagittal suture are two slightly raised osseous nodes, and the outer table in the lower frontal region is almost ivory-like in density. 3246

586. Part of a frontal bone, upon the inner surface of which a similar, but thicker and more extensive, deposit of new osseous tissue has been formed. On the right side two nipple-like prominences of bone project beyond the general surface, and in the middle line and along the line of the coronal suture the osseous deposit is thin and smooth. The anterior section shows that the new bone is indistinguishably blended with the old, and that the diploë is more compact than natural. 7259

587. Part of the left half of a frontal bone, upon the inner surface of which a deposit of new bone, similar to that in the two preceding specimens, has been formed.

It is probable that in this and the two preceding specimens the new bone has been deposited as the result of chronic syphilitic inflammation of the bone and dura mater.

588. The bones of the face, with adjacent portions of the frontal, sphenoid, and temporal bones. The external table of the frontal bone is irregularly destroyed

and undermined by ulceration, which, in places, has penetrated more deeply into its substance; on each side the lower part of the frontal sinus has been opened. Areas of bone isolated by the ulceration which has spread round them, and unaltered in appearance, remain scattered over the ulcerated surface. Of the nasal bones no part remains; and, after considerable destruction of their surfaces, the nasal processes of the superior maxillary bones, together with the front of the hard palate and adjoining portion of the alveolar border, have been almost completely separated after necrosis, being connected only by two slender pedicles near the inner margins of the orbits with the bone around. 2608

From a female patient, doubtless suffering from syphilis. She had taken much mercury. Some doubt as to the syphilitic nature of the disease is expressed in the original description of the specimen, because the hymen was found after death to be perfect.

589. Portions of the bones forming the roof of a skull, together with parts of the nasal bones, which were removed from a patient affected with syphilis. All of them bear marks of having been extensively ulcerated before their necrosis and separation. 2896

590. Two sequestra, the larger measuring 7 cm. by 5 cm., detached from the roof of a skull. They include the outer table with a small proportion of the diploë, and in one place the entire thickness of the bone; in the last situation the inner table is extensively undermined, the diploë having been destroyed by ulceration in excess of either table. 5416

These specimens differ from most syphilitic sequestra of the skull in that they exhibit but slight signs either of inflammation or of ulceration of the outer table previous to necrosis; in some parts the vascular canals are enlarged, but beyond this nothing more is recognizable. They resemble more closely, therefore, sequestra which have exfoliated as the result of injury.

From a woman who suffered from syphilis.

591. Part of a skull, including the bones and cartilages of the left nasal fossa. The frontal bone is thickened and sclerosed; the body of the sphenoid is similarly affected, and the surface of the dorsum sellæ is eroded. The anterior and lower part of the septum of the nose has been destroyed, and the posterior border excavated. Considerable loss of substance has occurred in the palate processes, and the mucous membrane covering the hard palate presents a small oval perforation. The lower parts of the nasal bone and the nasal process of the superior maxilla have been destroyed. 5858

R. F., a man aged 33, was admitted into U. C. H., under the care of Mr. Hill, October 21, 1882. The bridge of the nose was depressed; there was purulent offensive discharge from both nostrils, and a perforation opening into the left. Sinuses leading to bare bone on upper and lower margins of left orbit and on left zygoma; scarring of right cheek; pns in both conjunctival sacs, and opacity of right cornea. Subsequently superficial abscesses formed and were opened in the thigh, back, neck, and forearm. Diarrhœa set in on October 26. On November 3 the patient was drowsy and remained so. The temperature varied between 97° and 105°·2; on November 24 a rigor occurred. Death on November 25. No abscesses were found in any of the viscera. The apex of the right lung was fibroid and contained small collections of caseous pus. The membranes at the base of the brain were thick and opaque. (Mr. Hill's *Case-books*, 1883, p. 454.)

592. A left upper jaw, the inner wall of which has been completely destroyed, probably as the result of syphilis. The mucous membrane lining the antrum is thickened.

From the dissecting-room.

593. Parts of the palate processes of the superior maxillary bones, which were removed through the nose. Previously to their separation their inferior surface has been furrowed and pitted by ulceration. 120

From a syphilitic patient.



594. A vomer, together with the central portion of the hard palate, which has separated after necrosis.

2908

From a man, 46 years of age, suffering from the combined effects of syphilis and mercury. The soft palate and greater part of the hard palate were destroyed, and he had ulcers over his face and body.

595. Part of a right parietal bone, on the inner surface of which, covering its anterior third, is part of a thick layer of almost compact osseous tissue, with a slightly uneven or undulating surface, which has originated, probably, as the result of syphilitic periostitis. Beneath the margins of the new bone the inner table of the skull is readily traceable, but beyond this the new bone is indistinguishably combined with the proper substance of the parietal bone, the diploë of which has become sclerosed.

3244

596. The roof of a skull, the outer table of which is perforated over a large extent with numerous, small, close-set, circular apertures, the largest about 1 mm. in diameter, and which by their coalescence have formed larger ones of less regular shape and with minutely scalloped or crenated edges. The larger openings are collected into irregular ill-defined groups distributed chiefly over the parietal and frontal eminences, and correspond with the central portions of the subperiosteal gummata, in which the disease commenced; the smaller apertures are enlarged vascular canals, but no line of demarcation can be drawn between these and the larger ones. The smallest are traceable in all stages to the larger, and the larger to the more extensive irregular apertures formed by their confluence. The syphilitic growth was probably commensurate with the whole of the bone so altered. New osseous tissue has been formed at many parts, chiefly around or in the vicinity of the ulcerating patches, but in other parts in the midst of them, as if for the purpose of repair. The new bone is most abundant about the frontal region; but on the inner table, at parts corresponding with the disease on the exterior, a thin layer of porous or minutely reticulated, yet hard, bone has been formed. The whole of the frontal bone and the central parts of the parietal bones are considerably increased in thickness and density, rendering the calvaria much heavier than natural.

3250

The irregularity of the process is well marked; growth of new bone, ulceration, and chronic inflammation of the proper osseous substance, leading to sclerosis, are all in progress at one time and in different parts of the same bone.

597. The roof of a skull, showing on its outer surface countless minute circular pits, which in places have coalesced to form larger and less regular secondary ones, spread over its whole extent as far as the margin of the temporal fossa. In many situations the edges of the pits are smoothly healed and shelving, so as to form minute conical depressions; and some of the larger and more irregular of them are also smoothly healed, whilst in others the edges are sharp as if punched out, and slightly undermined as though ulceration were still in progress. As in the preceding specimen, a layer of new bone has been deposited on the inner surface; and the several bones have been greatly thickened and rendered very dense and ponderous by long-continued inflammation of their substance. The diploë of the bones has become uniformly compact in texture and indistinguishably continuous with the tables. Linear perforations are present in the coronal and sagittal sutures.

3254

598. The roof of a skull. The parietal bones towards the middle line, and the central part of the frontal bone near the coronal suture, are irregularly pitted by ulceration, which has, in most places, extended into the diploë, and has, in each situation, commenced apparently in closely-adjointing areas, which have afterwards coalesced. The ulcerating surfaces are soft and easily crushed. The inner table of the skull-cap is almost uniformly more porous than natural, the vascular canals being enlarged in consequence of chronic inflammation.

4961

599. A metopic skull-cap, which has become very dense and thickened from long-continued inflammation. In the frontal region, to the left of the frontal suture, are two ulcerated depressions which have healed. The edges of the depressions are smoothly rounded, and the cancellous tissue forming their bases is in some places partly, and in others completely, closed by thickening and coalescence of its lamellæ. The thickening of the outer table has taken place unevenly, and has so raised the surface for some distance around the ulcers as to make it slightly lobed and tuberculated. 3241

600. The right half of a skull. Ulceration has destroyed, with great irregularity, considerable parts of the outer table of the frontal and temporal bones, and parts of the entire thickness of the mastoid portion of the latter, in which a large opening exists; the petrous part of the temporal bone is likewise deeply ulcerated, the internal ear being laid open, and the roof of the tympanum wholly destroyed. In all these situations, except that last mentioned, broad portions of the bones, including in some places the inner table, lie loose after separation following their necrosis; corresponding with the posterior inferior angle of the parietal bone a scale-like portion of the inner table alone, about 3 cm. long, has been detached. The whole skull is considerably thickened, and the diploë in many places converted into dense compact substance. 5355

601. A skull-cap, on the left side of which an irregularly oval portion, about 14 cm. long and 8 cm. in breadth, including the entire thickness of the bone, has suffered necrosis after chronic inflammation and ulceration of its substance, and lies completely detached from the part around. The surface from which it has been separated is smoothly healed, and on both aspects overhangs the sequestrum, which has included somewhat more of the diploë than of either table. On the inner aspect of the detached piece the edges of the ulcerated depressions in it have been smoothly rounded, and the bone around them has been coated with a thin new layer previously to its total necrosis. Both the skull-cap itself and the portion of it which is necrosed are unnaturally thick and dense from chronic inflammation. 4255

602. The calvaria of an infant, the subject of congenital syphilis. In many parts the parietal bones are unusually thin, and the lower part of each is perforated, and the surrounding bone is minutely porous. The outer surface of the bones is the seat of a very thin, widely-distributed, osseous deposit. The inner surface of each parietal bone presents a lowly-raised thickening along each of its borders. 5528

603. The calvaria of an infant, the subject of congenital syphilis. On the outer surface of the frontal and parietal bones are irregular patches of very thin osseous deposit, producing a rough, sandy appearance, obscuring the normal texture of the bone. Similar and more marked deposits are present on the inner surface, especially about the parietal eminences. (From the same case as No. 453.) 7692

#### RICKETS.

Rickets is a disease of early childhood. Its essential feature as it affects the bones is a defect in the process of ossification, both at the epiphysial lines and beneath the periosteum. The most obvious external evidences of the disease are the enlargement of the ends of the bones (604) at the junction of the shaft and the epiphyses and the abnormal curvature of the shafts (604). Examination of a section through the enlarged extremity of a rickety bone shows a great increase in



thickness of the zone of proliferating cartilage and an irregularity in the extension of ossification into it, the new bone being large in amount, but very soft and spongy in texture (604, 605). These changes are best seen at the anterior ends of the ribs and at the lower extremities of the radius, ulna, and tibia. Examination of the shaft of a long bone shows that the new osseous tissue formed from the periosteum is soft and spongy (604). The healthy bone formed before the invasion of the disease is not softened, and is sometimes clearly distinguishable in the mass of diseased new bone (604). As the bone grows the healthy osseous tissue becomes gradually absorbed in the formation of the medullary canal, and at last only the soft rickety bone is left. The bones then bend in the direction of greatest pressure, and incomplete (greenstick) fractures are not uncommon (608). The curved bone receives support from an abundant formation of new bone in its concavity (620, 621, 622). In the skull the same excessive formation of spongy bone occurs beneath the periosteum, especially in the position of the frontal and parietal eminences and along the edges of the sutures (612, 613). When the disease ceases ossification is rapidly completed, and the bone may become unusually dense. The epiphyses often unite early, thus tending to dwarfing of the whole body (615, 616, 618).

*Fœtal Rickets.*—Although the signs of rickets rarely develop until after the first few months of extrauterine life, instances are occasionally met with in which undoubted evidences of the disease are present at birth (632).

604. The right femur of a rickety child, divided longitudinally with a knife. Its shaft presents a long forward bend, the curvature, however, being less marked posteriorly than anteriorly, owing to an increased production of osseous tissue which forms a sharp ridge along the concavity of the curve. The section displays a great excess of growing tissue preparatory to ossification both beneath the periosteum and from the epiphyses. The semitransparent gelatinous-looking line between the bone and the cartilage at each end is much thicker than natural, and instead of being uniform in thickness is jagged and irregular, medullary spaces advancing beyond it into the unaltered cartilage. The deposition of lime salts in all the new bone is very imperfect. The excessive growth of the soft new bone is most marked opposite the junction of the shaft and the epiphyses, giving rise to the characteristic nodular swelling at these points, which causes the apparently enlarged joints of rickety children. In the midst of the soft new bone can be seen the remains of the healthy bone existing before the disease commenced, which can be recognized by its more compact structure and less opaque look. The upper and lower extremities of the old bone are now distant nearly 2 cm. from the cartilage of the epiphysis. By absorption of its inner laminae in the formation of the medullary canal its cortex has become somewhat thinned, and it is bent acutely from the yielding of the soft new bone. Its posterior wall appears almost as if fractured, the anterior angle projecting within the medullary canal so as nearly to occlude it. A small quantity of new bone has been formed round this angle in the medullary canal.

605. The upper and lower extremities of a femur, and a section of part of a rib. Both extremities of the femur show well-marked evidences of rickets at the line of ossification. At the lower extremity the layer of proliferating cartilage is especially distinct, and above this is seen a yellowish, irregularly vascular, zone of ossification 6 mm. in thickness.

The costal cartilage at its junction with the rib is considerably enlarged, and between the normal cartilage on the one hand and the normal bone on the other is a zone nearly 1 cm. in thickness, which, except in a narrow dense layer next the bone presents to the naked eye an almost gelatinous appearance, marked by small vascular spots and yellowish streaks, probably of calcification.

From a male infant aged 16 months, who presented signs of rickets and in whom there was profound anamia with enlargement of the liver and spleen. The spleen and calvaria are preserved in the Medical Series. (Dr. Barlow's *Case-books*, Children, 1897, p. 494.)

**606.** The bones of the lower extremity of a child, altered by rickets. All of them are very porous, light, and increased in size, their surfaces, especially those of the femur and ilium, being at parts of so finely porous a texture as to appear almost velvety. The shaft of the femur presents a long antero-posterior curvature, and the longitudinal section of the bone shows that the layer of spongy subperiosteal bone is most abundant along the concavity of the curve. The tibia and fibula are scarcely deformed. 1706

**607.** Part of the skeleton of a child, about six years old, affected with rickets. The cranium, especially posteriorly, is enlarged; the bones forming the vault of the skull are increased in thickness by the growth of a spongy cancellous tissue, similar to that in No. 604, and their tables are no longer distinguishable. The increase is most marked in the parietal bones, which are 16 mm. thick. At the edges of the several bones the enlargement is less, the sutures coming to lie in shallow sulci. The curves of the clavicles are increased, and the humeri, which have a greater circumference than natural, are bent outwards opposite the insertion of the deltoid muscles, and the ends of their shafts are enlarged. On both sides the seventh and eighth ribs, and on the right the sixth also, have been repaired after having been fractured at or behind the middle of their length.

The bones of the forearm are curved slightly backwards at their upper part and outwards at their lower. There is scarcely any deformity of the spine or ribs; the anterior ends of the latter are slightly enlarged. 391

**608.** The skeleton of a child, about two years old, who suffered from rickets. All the bones forming the skull are slightly thicker than natural; those of the face have a stunted appearance, which is increased by the prominence of the forehead; the anterior fontanelle remains widely open. The whole spine presents a long backward curvature. The anterior ends of the ribs have fallen inwards on the left side to a less degree than on the right, owing to the resistance offered by the heart; and the sternum with its cartilages has been forced forwards so as to form a sort of secondary cavity to the thorax: on the right side the angles of the ribs are reduced to right angles, and on the left they are less obtuse than natural. The curves of the clavicles are exaggerated, and the lower parts of the scapulae bent outwards in conformity with the altered shape of the chest.

The shafts of the humeri are doubled outwards, and, in a much less degree, the bones of the forearm, these deformities arising from the action of the deltoid and from the habit which such children acquire of fixing the trunk by resting the extended hands upon the thighs, in order to lessen the difficulty of breathing.

In the femora the curvature is forwards, and is due to the weight of the legs having acted upon their lower ends as the child was carried on the arm.

The left femur has been repaired after a fracture near the middle of its shaft; the ends of both thigh-bones are enlarged. The tibia and fibula on the left side are bent inwards; on the right their form is natural. By the shortening of the several bones, the contraction of the chest, and bending of the spine, the skeleton appears diminutive, and the size of the head still further exaggerated. 3131

**609.** A model of the front of the chest taken from a child who died, when sixteen months old, with rickets. As a result of their softness the ribs have become folded upon themselves, their anterior extremities projecting inwards so as to form a regular series of rounded projections within the thorax corresponding with the line of junction between them and their cartilages. On the left side, where its walls have been supported by the heart, the cavity of the thorax, as far as the fifth rib inclusive, retains its natural shape.

The ends of the ribs are slightly enlarged.

4176



610. A plaster cast of the chest, taken from the same child. On the left side the series of prominences formed by the enlarged ends of the ribs is readily discernible. Towards the lower part of the chest, on the right side, the situation of the liver is strongly marked by the sudden falling-in of the chest immediately above it.

611. The left half of a sternum, together with the upper seven rib-cartilages and adjacent parts of the corresponding ribs, from a rickety infant. Marked beading of the ribs has resulted from enlargement affecting the costo-chondral junctions. Sections made through the fifth and seventh show that the enlargement involves both the rib and its cartilage. In the latter the zone of proliferating cartilage-cells is of unusual thickness, and is distinguishable from the normal cartilage by its colour and greater transparency. In the rib the line of ossification is also increased in thickness and is advancing irregularly into the cartilage. 5856

612. The calvaria of a rickety infant. The skull is large and the anterior fontanelle is widely open; the sagittal suture and the parts of the frontal suture contained in the specimen are unusually distinct and lie in a shallow sulcus. The bones are very unequal in thickness; around the anterior fontanelle and in the posterior part of the right parietal they are thin and translucent, whilst on the left side and in front the section has a maximum thickness of 6 mm. The thickened bone is soft, and the tables and diploë are indistinguishable from each other. In the occipital bone there is a small area of defective ossification closed only by membrane. 6756

A. G. F., a very anæmic male infant, aged 22 months, was under the care of Dr. Barlow in U. C. H., 1891, and died of broncho-pneumonia with diarrhoea and vomiting. The signs of rickets were well marked. Brain 38 oz.; ventricles not dilated. The spleen which reached to the iliac crest, weighed 5 ounces. The liver weighed 16 ounces. (Dr. Barlow's *Case-books*, Children, 1891, p. 308.)

613. Part of the calvaria of an infant. The bone varies much in thickness, being in some parts, especially in the parietal, very thin, pale, and translucent. On the frontal bone there is a rounded boss, in the position of the eminence, measuring 3 cm. in diameter. The thickening has resulted from a formation of vascular bone on the outer surface. Similar but less marked and more irregular thickenings, involving both the inner and outer tables, are present on the parietal bone. The anterior fontanelle is widely open. 7820

From a male infant aged 14 months, who presented well-marked signs of rickets and died of broncho-pneumonia. There was great pallor, with enlargement of the liver and spleen, which subsided before death. (Dr. Barlow's *Case-books*, Children, 1897, p. 252.)

614. The pelvis of an adult sometime affected with rickets. It is oblique and much flattened from before backwards, the sacral promontory being separated by 6.5 cm. from the pubic symphysis. The transverse diameter of the pelvic brim is 12 cm. Each iliac bone is compressed antero-posteriorly so that the acetabulum looks directly forwards. The iliac fossa is transversely hollowed, and the posterior part of the bone is nearly vertical. The sacrum is sharply curved in its lower part, and is tilted so that its base looks almost directly forwards; the whole bone is more deeply placed than natural between the two hip-bones. The outlet of the pelvis is capacious, its transverse diameter measuring 11 cm. 172

615. The bones of the upper extremities of an adult in whom recovery from rickets has occurred with permanent deformity. In the left clavicle the curves are somewhat more marked than natural, and, relatively to its shaft, its articular ends are considerably increased in size. The shaft of each humerus is irregularly thickened at its middle and slightly bent outwards. The normal curves of the forearm bones are exaggerated. All the bones are stunted in growth, the length of the limbs being considerably below the average. 250

616. Part of the skeleton of an adult showing recovery, with deformity, from

rickets; the edentulous condition of the jaws shows the subject to have been of considerable age. In all the bones growth has been retarded so as to cause dwarfing of the skeleton. The deformity remaining in the upper extremities is almost identical with that existing in the preceding specimen.

A fracture through the neck of the right humerus has been repaired after slight displacement of the fragments.

In the lower extremities, as in the upper, the altered shape of the bones is the only indication of the disease which remains, the osseous tissue itself being firm and healthy. Strong supporting ridges of compact bone have been produced within the concavities of the curves, giving to the several bones a characteristic flattened form. The angle of junction between the neck and shaft of the femur is diminished to a right angle. The lower ends of the femora are also altered in shape, being compressed from above and widened laterally. Outgrowths of bone, formed as a result of chronic rheumatoid arthritis, project from the inner condyle of the left femur.

3132

617. The right humerus of an adult, in which recovery from rickets has occurred. Signs of the disease remain in the slight outward curvature opposite the insertion of the deltoid, in the antero-posterior flattening of the lower part of the shaft, and in its somewhat enlarged articular ends.

618. A right femur slightly curved forwards as the result of rickets, which has at some time affected it. Its length does not exceed 25 cm.

The lower end is considerably altered in shape, and its articular surfaces are surrounded by bony outgrowths, due, apparently, to rheumatoid arthritis. In texture the bone is firm and healthy.

619. A left femur presenting characters similar to those of the preceding specimen, and probably from the same subject.

620. The right femur of an adult, at some time affected with rickets, in which recovery has occurred with considerable deformity. The shaft of the bone is curved with the convexity forwards and outwards, and is flattened, in its lower part from before backwards, in the rest of its extent from side to side; the flattening in the latter situation is increased in appearance by a ridge of bone which has been added within the concavity of the curvature.

Its lower articular end is unnaturally large.

3009

621. The right femur of an adult, showing recovery from rickets. With the exception of the forward bend of the shaft and the broad ridge of compact tissue occupying its concavity behind, the whole bone presents a natural appearance. The angle of the neck is unaltered.

2992

622. A longitudinal section of a right femur which had been affected with rickets, showing the condition of the osseous tissue. The ridge filling the concavity of the curvature is composed entirely of densely compact bone, and the greater part of the medullary canal is occupied by a coarse network of osseous substance, the lamellæ of which are very thick and firm, and are arranged chiefly in a longitudinal direction: the structure of the other part is unchanged.

2994

623. A right tibia which has at some time been affected with rickets. The deformity remaining is somewhat similar to that in No. 616; but in addition to the antero-posterior bend near the junction of its middle and lower thirds, the shaft is markedly bent inwards, the point of greatest curvature being at the junction of the middle and upper thirds.

2976

624. A left tibia and fibula which have been affected with rickets. Both the bones show very marked curvature inwards. The middle two-fourths of the tibia,



where the curvature is most extreme, is greatly flattened antero-posteriorly. The maximum curve of the fibula is below its middle, where the bone shows a similar flattening. The lower extremity of each bone has been rotated outwards, but otherwise the extremities are normal.

7279

625. A longitudinal section of the bones of a right leg which have been bent inwards from rickets, and in which recovery has occurred.

The compact wall of the tibia within the curvature is 6 mm. in thickness, at its convexity rather less. The medullary canal at this part is occluded by the growth of coarsely cancellated bone with firm lamellæ, which lie for the most part in vertical planes. The shaft of the fibula is exceedingly flattened in the antero-posterior direction, measuring nearly 3 cm. in breadth and about 8 mm. in thickness at its thickest part.

At a short distance from their lower extremities, where the bones have lain in close contact, they are firmly united.

3044

626. A vertical section of the bodies of some of the vertebræ, from a case of foetal rickets. The trabeculæ enclosing the unusually large cancellous spaces are thickened and composed of finely porous bone. Between the bone and the cartilaginous epiphysial plates is a grey semitranslucent zone, probably representing the layer of proliferating cartilage-cells preceding the process of ossification.

627. A tibia, from the same case, in vertical section. In the wall of the shaft two distinct layers are in most parts recognizable: an inner laminated layer of apparently normal bone, and an outer thicker layer of subperiosteal bone which in parts presents a faint striation vertical to the surface. The interior of the shaft is altogether wanting in cancellous tissue, and the large medullary canal contains marrow which in the present condition of the specimen is of a dirty yellow colour and in parts apparently hæmorrhagic. At its extremities the diaphysis consists of finely porous bone, the cancellous spaces of which, at the upper extremity, are unusually large, but few in number, and at the lower extremity are represented by a few irregular lacunæ. The zone of ossification at the junction of the epiphysis and shaft is unusually thick and irregular. The bony centre in the upper epiphysis is very coarsely cancellated. The whole bone presents an undue curvature forwards.

628. A humerus, from the same case, in vertical section. The bone presents changes similar to those described in the previous specimen. At its upper extremity the irregularity of the process of ossification is especially well shown.

629. An ulna, from the same case, in vertical section. The specimen shows changes similar to those in the two preceding ones.

630. Some of the bones of the foot and hand, from the same case, in section. The osseous tissue presents the same changes as in the preceding specimens.

631. A humerus and tibia, with some of the bones of the foot, in section, from a rickety infant. The bones show changes which are in every respect remarkably similar to those seen in Nos. 627 and 628. The two long bones are much curved, and the medulla of the tibia shows numerous brownish areas resulting from extravasation of blood.

6382

From a child under the care of Mr. Godlee at the N. E. Hospital for Children. It was thought to be suffering from inherited syphilis, but was quite unrelieved by antisyphilitic treatment and careful dieting. Death resulted from marasmus.

632. The skeleton of a rickety foetus. The cranium is large and the face small. The ossification of all the flat bones of the cranium is defective, irregular plates of very thin bone being widely separated by intervals which are in parts entirely membranous, and in others are undergoing ossification in irregular striæ. In

many parts the bone is so thin as to give to the finger a sensation like the crackling of parchment, the thinness being such that the shape of the skull could only be maintained by filling the cavity with wool. The lower jaw is fractured on each side in front of the masseter. The vertebral column presents a normal appearance. The wall of the thorax presents on each side a vertical groove outside the junction of the ribs with their cartilages. The ribs are sharply bent at their angles, especially on the right side, and there are several swellings of the bones in this situation which appear to indicate the seat of fractures. (The clavicle and scapula are wanting on each side.)

In the right upper extremity the humerus is curved outwards as the result of a healed fracture in the middle of its shaft; there is a recent fracture close to the lower extremity; the upper extremity of the shaft is considerably thickened. The radius and ulna present an enlargement in the middle of their shafts following the repair of a fracture; each bone has also been recently fractured in the upper and lower part of its shaft, and the lower end of the shaft of each is thickened.

In the left upper extremity the humerus is curved outwards even more markedly than the right, and presents two ununited fractures below its middle. The ulna is fractured about its middle and the radius at a lower level. The fifth metacarpal bone is fractured at its lower end.

The pelvis is flattened from before back and its cavity contracted. The inlet of the true pelvis has the shape of a triangle with the corners rounded. The left ilium is fractured transversely a little below the crest.

In the right lower extremity the femur is bent outwards and the leg-bones prominently forwards, so that the thigh- and leg-bones together have the outline of a semicircle. The femur presents two repaired fractures, one at and the other above the middle, and an ununited fracture midway between the middle of the shaft and the lower epiphysis.

The leg-bones are the seat of unrepaired fractures in the middle of their length, and the fibula also at its upper extremity. The foot-bones are normal.

The general appearance of the bones of the left lower extremity is similar to that of the right. The femur is fractured at the middle of its length, and the leg-bones in two places at and below their middle.

In both limbs the ends of the long bones are considerably enlarged, and, as in the upper limbs, the growth in length of the long bones is deficient. 6690

#### ACHONDROPLASIA.

The rare condition known as Achondroplasia, sometimes spoken of as Foetal Cretinism, has been met with chiefly in foetuses which were stillborn or in which death almost immediately followed birth. The most noticeable external appearances are stunting of the limbs and an accumulation of subcutaneous fat (635). The changes in the skeleton are limited to those bones which are developed in cartilage. In the long bones the changes are (1) impaired growth in length of the shaft (635), (2) exaggeration of the normal curvatures (639, 640), and (3) enlargement of the ends of the shaft which are cupped to receive the epiphyses (634, 640). In relation to the stunted shaft the epiphyses, which are of normal size, appear large. Examination of the line of junction of the shaft and epiphysis shows: (1) an ingrowth of fibrous tissue from the periosteum (635) and (2) an absence of the normal row-formation of the cartilage-cells in the epiphysial line. The enlargement and cupping are also very pronounced in the ribs at the junction with their cartilages. The only important change in the cranium is stunting of the length of the basis cranii due to premature synostosis of the basisphenoid and basioccipital (633).



**633.** The right half of the skull of a foetus the subject of achondroplasia. With the exception of the tabular part of the occipital bone, the development of the cranial vault is normal. The lower part of the tabular portion (supraoccipital), which is developed in cartilage, is much stunted, so that the internal occipital protuberance, instead of being situated near the middle of the bone, forms with the internal occipital crest only a thick projection immediately behind the foramen magnum. The measurement from the anterior border of the foramen magnum to the front of the body of the sphenoid bone is greatly diminished, and the basisphenoid is prematurely ankylosed to the presphenoid in front and the basioccipital behind. The foramen magnum is small and its edges vertical, the basilar groove being also unusually steep. 5575

**634.** The vertebral column, together with the thorax and pelvis, from the same foetus as the preceding specimen. The vertebrae are normal. The sternum and costal cartilages show no ossification. The ribs are distinctly beaded, the enlargements being limited to the extremities of the bones and forming cups ensheathing the ends of the cartilages. The thorax presents on each side a shallow vertical groove in the line of the costo-chondral junctions. The pelvis is greatly compressed antero-posteriorly, the iliac portions are more horizontal than normal, and on both surfaces the margin of the bony portion overlaps the epiphysal cartilage of the crest. 5575

**635.** The bones of the left upper extremity, together with the soft parts of the hand, from the same foetus as the preceding specimens. The clavicle is well developed. "The scapula shows a marked overlapping of the epiphysal cartilage by bony sheaths. The humerus shows relatively large epiphyses and a short, stout shaft." "There is no ossification of cartilage forming digitate processes along the line of ossification such as one sees in true rickets. Along the upper line is a fibrous lamina which has grown in from the periosteum. There is a premature ossifying centre in the upper epiphysis quite eccentrically situated, viz. just above the fibrous lamina referred to, and probably arising in connection with this fibrous tissue invasion. The shaft is short and stout, and presents a marked concavity forwards, with projection backwards at the lower end. The lower line of ossification is regular, but unnaturally convex. There is no fibrous invasion here, and no nucleus in the lower epiphysis." The radius presents a striking exaggeration of the normal curve. "The hand is short and stunted, and there is a considerable accumulation of subcutaneous fat." 5575

The child from which this specimen and the two preceding ones were obtained was born at full term of a healthy mother who had previously given birth to 5 healthy children. It was extremely blue at birth, and breathed only for a few seconds. There was a general accumulation of fat in the subcutaneous areolar tissue. The thyroid gland was natural to naked-eye inspection. The base of the brain presented an abnormal arrangement of its parts, probably dependent upon the deformities of the basis cranii. The heart presented valvular and septal malformations. (See Dr. Barlow, *Trans. Path. Soc.* vol. xxxv. 1884, p. 459.)

**636.** The right temporal bone, together with the right half of the sphenoid and occipital bones, from a foetus affected with achondroplasia. The antero-posterior section through the basis cranii shows that there is a complete synostosis of the basioccipital, basisphenoid, and presphenoid. The foramen magnum is small and its margin steep. The tabular portion of the occipital bone (supraoccipital) shows the same imperfect development of the cartilage-formed portion as is seen in No. 633. "The internal occipital spine rises at the junction of the lower with the middle third of the median ridge, instead of rising at or near its middle point," and the small sulcus which marks the line of union of the lower cartilage-formed part of the bone with the upper membrane-formed part is much lower down than normal. 5537

**637.** Part of the spinal column, together with the ribs and rib-cartilages of the right side and the right half of the sternum, from the same foetus. The vertebrae

are normal. "The sternum and costal cartilages show no ossification. The ribs present distinct nodosities, but instead of being at the junction of ribs and cartilages these nodosities definitely belong to the bone, and each consists of a bony cup which surrounds the end of the cartilage like a sheath." 5537

638. The left clavicle, scapula, and humerus from the same foetus. "The clavicle is natural; it is longer than either humerus or ulna (it will be remembered that the clavicle is a membrane-formed bone). The scapula shows much thickening of bone where the cartilage joins it, and there appear to be two thick lips, including the edge of the cartilage. The humerus shows relatively large upper and lower epiphyses, and a short, stout shaft. On section it is seen that the epiphyses are cartilaginous throughout. There is no irregularity in the line of ossification, and no massing up of pale bluish material such as is seen in a typical rickety long bone at the junction of shaft and epiphysis. The bone of the shaft is hard and compact on the surface, and cancellous in the middle." At the outer side of the upper extremity there is a very slight extension of bone at the base of the great tuberosity. 5537

639. The bones of the left forearm, together with the hand, from the same foetus. The radius and ulna are short and thick, and the epiphyses relatively large. "The radius is exceedingly oblique in its direction, and presents a striking sigmoid curve with the pronator tubercle in the centre." The hand is thick, and the fingers short and stunted; there is a marked accumulation of subcutaneous fat, causing prominent folds in the palm and on the fingers. 5537

640. The left half of the pelvis, together with the bones of the lower limb, from the same foetus. The pelvis is flattened antero-posteriorly, and the great sciatic notch much narrowed. The ilium is thick, and the epiphysis of the crest is received into a shallow groove in the bone, caused by the extension of ossification on both surfaces of the cartilage. The shaft of the femur is short and stout, and bent markedly forwards; its extremities are relatively large; there is no ossific deposit in the lower epiphysis; the lower end of the bony shaft forms a shallow cup to receive the cartilaginous epiphysis, and at the junction of the two a fine white line of fibrous tissue extends across from the periosteum. The tibia and fibula present similar external appearances; the former is straight and the latter bowed backwards and outwards. The foot-bones appear normal; there is a centre of ossification in the os calcis. 5537

This and the four preceding specimens were obtained from a stillborn child, believed to be of full term. "There was nothing in the family history which would throw light upon the case, excepting the fact that one previous child out of a large number was born with 'turned feet.' The proportions of the foetus were very remarkable. There was nothing special about the head and trunk; the neck was short and thick, the limbs stunted. The upper limbs placed close to the body did not extend further down than the umbilicus, and the lower limbs from the ilium to the heel only measured 5 inches. There was a remarkable accumulation of subcutaneous fat, and the arms, forearms, fingers, and to a less degree the lower limbs presented numerous transverse folds. The lungs were not expanded. There was no gross disease in the viscera." (See Dr. Barlow, *Trans. Path. Soc.* vol. xxxii, 1881, p. 364.)

641. A clavicle and scapula, together with the long bones of the upper and lower extremities, from a foetus the subject of achondroplasia. The clavicle is normal, and longer even than the shaft of the forearm bones. The scapula is thick, especially at the junction of the body with the lower part of the vertebral epiphysis. The surface of the bone is minutely porous, and the coracoid process, which is osseous except at its extremity, has already become ankylosed with the rest of the bone. The long bones of the extremities are stunted in length and present the following characters: "the ends of their shafts are greatly enlarged and widely overhanging, the margin of the outspread part being sinuous, dentate or jagged, and raised beyond the terminal surface on which the epiphyses have been received." In the humerus, "portions of the surface are minutely porous and lowly raised,



apparently from a localized periostitis. The apparent deposit of inflammatory bone is especially evident in the back and lower part of the shaft, and similar thin depositions have occurred on various portions of the radius and ulna." The shaft of the femur is laterally compressed, and the section shows nothing abnormal.

5536

From a child stillborn, probably at full term. The other changes in the skeleton were similar to those described in the preceding specimens. (See Mr. S. G. Shattock, Trans. Path. Soc. 1881, vol. xxxii. p. 369.)

#### MOLLITIES OSSIUM. OSTEOMALACIA.

The specimens illustrate the following points. Mollities ossium is a disease solely of adult life, and most frequent in pregnant women who have borne many children. In it the bone undergoes a process of decalcification, spreading from the Haversian canals. Later in the disease many of the lamellæ of the cancellons and also of the compact tissue disappear, rendering the bone more spongy than natural (645). In the early stages the vessels are full of blood, and the spaces filled with a red pulp containing multitudes of lymphoid corpuscles. Later on these may undergo fatty degeneration, and the spaces thus become filled with fat, though in the early stages the bone contains less fat than natural. There is generally a thin layer of almost unaltered bone left beneath the periosteum. In consequence of the softening resulting from these changes the bones bend in the direction of greatest pressure. The long bones frequently undergo spontaneous fracture. The bone is greatly diminished in specific gravity. It may even float in water.

642. A female pelvis showing the deformity resulting from osteomalacia. The sacrum, together with the adjacent parts of the iliac bones, has been forced downwards and forwards by the weight of the trunk, and at the same time the sacrum has been rotated so that its dorsal surface looks almost directly upwards. As the result of these displacements, each iliac bone is folded on itself so as to produce a deep, nearly transverse grooving of the iliac fossa, more pronounced on the left side, the posterior half of each bone being flattened so as to lie in an almost horizontal plane. As the result of the transmission of the weight of the trunk to the heads of the femora, the acetabula have become approximated towards each other and towards the sacral promontory, thus producing a sharp bend in the pubic rami and displacing the symphysis forwards in the form of a prow or rostrum. The acetabula look more forwards than natural. Neither the transverse measurement of the inlet nor its antero-posterior is much diminished, the chief contraction being in the oblique diameters, especially the left, and arising from the approximation of the acetabula towards the upper part of the sacrum. The outline of the pelvic inlet is triradiate in form. The bones, which can be cut with a knife, are considerably diminished in weight. On the ventral surface of the ilia are rough, shallow depressions in the bone, in some of which actual perforations exist.

4231

The patient, aged 30, during the first sixteen years of her married life gave birth to seven children, all of which were born at full term and without difficulty. Three or four months previous to the birth of her seventh child (May 29, 1856) she felt constant uneasiness and dull aching pain in the back and thighs, which was increased by walking. Parturition, however, occurred naturally, lasting only two hours. In October 1857 she again became pregnant; the pain and difficulty in walking increased; still she was able to get about till January 1858. Labour commenced on July 8, but on July 12 had made no progress. The deformity of the pelvis being found so great that the removal of the child, even by perforation, was impossible, the patient was brought to the hospital and Cæsarean section performed by Mr. Quain and Dr. Murphy. The child was dead; the mother died on the second day after the operation. ('Lancet,' December 18, 1858, p. 631.)

643. A model in wax of the preceding pelvis.

4232

644. The pelvis, with part of the spinal column and the upper ends of the femora, from a case of osteomalacia. The deformity of the pelvis, although more symmetrical and more pronounced, is very similar to that in the foregoing specimen. The portions of the thigh-bones shown preserve their natural form; but the spine is acutely bent to the left side about the middle of its dorsal region, and the column below presents two long, shallow, compensatory curves, the upper towards the right, the lower to the left; the sacrum also is doubled upon itself by the downward displacement of its upper half.

All the bones are exceedingly greasy, and, with the exception of the shafts of the femora, are sufficiently soft to yield to a knife; the cancellous tissue of the femora has in great part disappeared, the medullary canal having an area about twice as large as is natural.

645. A slice of a lumbar vertebra, together with part of the shaft of a femur, showing the changes produced by osteomalacia. The cancellous tissue of the vertebra presents unusually large and irregular spaces due to the thinning and disappearance of many of the osseous trabeculae. The superficial layer of compact bone is very thin and in parts has entirely disappeared, so that the superficial cancellous spaces are only closed by the periosteum. The compact tissue of the femur is thinner and slightly more porous than natural. The cancellous tissue has almost entirely disappeared, so that the medullary canal is much increased in size. The osseous tissue retains its density and can hardly be cut with a knife. 5855

From the dissecting-room. The pelvis and vertebral column were deformed in a manner similar to the preceding specimen.

#### OSTEITIS DEFORMANS.

Osteitis deformans is a very chronic affection occurring in the middle or late periods of life, and is characterized by enlargement and deformity of the affected bones. These are chiefly the cranium, spine, clavicles, tibiae, and femora. The cranium gradually enlarges as the result of increasing thickness of the bones composing it (646, 653 A), whilst the face-bones, with the exception sometimes of the lower jaw and malars, escape. The spine is bent forwards from an increase of the dorsal curve. The affected limb-bones are enlarged and their curvatures exaggerated (650, 654); thus the femur becomes bowed outwards, whilst its neck becomes more horizontal, and the tibia presents an exaggerated curvature forwards. The first noticeable deformity is usually either the enlargement of the head or the curvature of the tibia. The changes in the osseous tissue appear to be inflammatory in nature; the compact bone which is increased in thickness is in parts dense and in others spongy, and the distinction between it and the cancellous bone is more or less lost (646). The dense, spongy, osseous tissue is composed of coarse trabeculae enclosing spaces filled with fibrillated cellular tissue. In a considerable number of cases death has occurred from multiple sarcomata (646 *et seq.*).

646. A portion of the calvaria from a case of osteitis deformans. The bone is greatly increased in thickness, measuring in its thickest part 15 mm. The outer surface of the bone is smooth, and the inner surface very deeply marked by the grooves for the meningeal vessels. No trace of the sutures is recognizable. The section presents a uniformly dense structure, and the distinction between the diploë and the inner and outer tables has been obliterated. There is, however, a slight mottling of the cut surface, due to the presence of areas which are somewhat



paler in colour and softer than the rest. These softer areas bear no relation to the normal position of the diploë, and some of the most sclerosed patches are in the centre of the section.

In addition to the diffuse changes above described, the skull presents numerous localized new growths, both on its outer and inner aspects. These, though varying considerably in size, are mostly rounded in outline; many are about the size of a six-penny piece, and in their thickest central part are raised to the extent of 4 or 5 mm. The consistence of the growths varies; some are quite soft, but others are gritty as if ossifying. The periosteum can without difficulty be separated from the surface of the growths, but the relation of the latter to the bone is not constant. Whilst in some the growth can be peeled without much difficulty from the smooth bone beneath, in others the connection between the two is more intimate and the surface of the bone is pitted and actually invaded by the growth. 5831

The colour of this and the following specimens has resulted from preservation in a solution of bichromate of ammonium.

647. The left half of the base of the skull and of the face-bones, from the same case as the preceding specimen. The cranial bones present changes similar to those already described. A mass of soft growth covers the temporal surface of the great wing of the sphenoid. The malar bone is thickened; the alveolar process of the upper jaw is much enlarged, its posterior extremity presents a soft deposit, and a section through the centre of the alveolar process shows small soft spots of growth in the substance of the bone. Examination of the median section of the skull reveals great enlargement of the body of the sphenoid, the bone forming the floor of the sphenoidal sinus being 12 mm. in thickness. The sinus itself is in part filled with ossifying growth which projects forwards in the form of a soft mass into the sphenoidal recess. From the front of the body of the sphenoid soft growth extends forwards into the back of the nasal fossa, involving the vertical plate of the ethmoid. On the inner wall of the orbit the growth is extending through the bone from the ethmoidal cells. 5831

648. A median section through the bodies of some of the vertebræ of the lower part of the spinal column, from the same case as the preceding specimens. The substance of the bodies varies much in appearance, being in parts normal, in others sclerosed, and in others apparently infiltrated with soft growth. Springing from the outer surface of three of the bodies is a prominent mass of growth which is in part firmly ossified. 5831

649. A piece of the ilium, from the same case as the preceding specimens. The bone is not thickened, but in section, particularly in the neighbourhood of the crest, it is infiltrated with growth. A large mass of soft solid growth projects from each aspect of the bone. 5831

650. A longitudinal section of a femur, from the same case as the preceding. The only alteration in the shape of the bone is a slight increase in the normal curve of the shaft, especially in its lower part. The section shows an almost general thickening of the wall of the shaft, the compact tissue of which is in parts separated into thick parallel trabeculæ, the intervening spaces being occupied by soft growth. The medullary canal is the seat of four separate tumours, which are homogeneous in appearance and firm and gritty in consistence. On the surface of the shaft beneath the periosteum are several deposits of growth in every respect similar to those described on the skull (No. 646). The cancellous tissue of the two extremities of the bone has undergone a varying degree of sclerosis, and also presents irregular patches in which the osseous tissue is replaced by soft growth. The articular cartilage is unaffected. 5831

51. A longitudinal section of a tibia, from the same case as the preceding. In all respects, with the exception of the presence of superficial growths, the bone presents features similar to those seen in the femur. 5831

E. S., an unmarried woman, aged 43, was admitted into U. C. H. under Dr. Ringer, May 27, 1880. She had had rheumatic fever in 1874, and since Feb. 1878 had complained of shortness of breath on exertion and "neuralgic" pains in the limbs. In March 1878, thickening of the radii and to a less extent of the tibiae was noticed; the upper and lower jaws were enlarged, and the head was massive. Following diphtheria, in April 1878, ascites and oedema of the legs occurred, and in the summer of 1879 she had double pleurisy. On admission, the lower ends of both humeri were enlarged; the forearm bones were bent and thickened; the clavicles were much thickened, especially at the inner ends; the lower jaw and the alveolar border of the upper jaw were enlarged; cranium enlarged; spine normal; femora not enlarged, but curvature increased. There was an apical systolic murmur, and the abdomen was distended with fluid. Sight and hearing were defective. A few days after admission power in the lower limbs was almost completely lost. Patient became gradually weaker, and died August 29, 1880. At the *post-mortem* examination sarcomatous growths were found in the lungs, pleurae, bronchial glands, heart, peritoneum, retroperitoneal tissue, liver, skull, vertebrae, right ilium, femora, and tibiae. (Dr. Ringer's *Case-books*, 1880, Females, p. 773.)

*Microscopic Characters. Skull-bones.*—There is no recognizable line of demarcation between the tables and the diploë, the whole thickness of the bone being made up of trabeculae which are for the most part stout, closely set, and evenly distributed. Only in a few places is there any evidence of absorption or deposition on the surfaces of the trabeculae. The mottling of the bone mentioned in specimen No. 646 results from differences in the thickness of the trabeculae. The medullary spaces are occupied by soft tissue, the structure of which is similar to that of the definite tumours, and the same process of ossification is observable in it.

*Tumours of the Bones.*—These have a mixed sarcomatous structure. The cells are for the most part rounded or oval in shape, and lie in a finely reticulated stroma. In irregular areas this reticular stroma becomes hyaline and thickened, this process representing apparently an early stage in the process of ossification. The substance of the tumours on the surface of the bones is directly continuous, through the superficial layers of the osseous tissue, with the growth which fills the medullary spaces. In the tumours of the lung (*see* Medical Series), which agree in structure with those of the bones, changes similar to those above described are seen in the stroma, and in the areas so affected trabeculae of actual bone have in parts been formed.

652. The bones of a skull, excepting the lower jaw. The cranium is large, measuring 15 cm. in its greatest transverse diameter, and 20 cm. in its antero-posterior diameter; it is rendered asymmetrical by a bulging of the left occipito-parietal region. The bones of the cranium are increased in thickness, especially in the frontal and occipital regions, measuring nearly 2 cm. at the thickest part. The distinction between the tables and the diploë has disappeared, the section presenting a uniformly spongy texture, and the smooth internal surface of the skull being almost everywhere replaced by one which has a closely porous structure, and exactly resembles the condition of the exterior, which is similarly altered. Excepting the coronal, no trace of the sutures in the vault remains. On the inner surface the grooves for the vessels are exaggerated; the jugular foramina are contracted, but the other apertures in the base of the skull retain their normal size. The thickened orbital plates of the frontal bone are so prominent that the horizontal plate of the ethmoid is sunk in a deep hollow. No trace of the frontal sinuses appears in the section. All the parts immediately surrounding the foramen magnum appear to have been driven upwards, rendering the basilar groove more horizontal than natural, producing a corresponding hollow on the under surface of the base, and giving to the foramen magnum a triangular form. The surfaces of the bones forming the middle fossa of the base of the skull are less affected than the rest, for, although irregularly tuberculated, the compact surface remains.

The upper jaws are affected in a manner similar to the cranial bones, the thickening being most marked in the palate, which is on a level with the alveolar border. The malar and nasal bones are not affected, and the orbits are not encroached upon. The face is asymmetrical, the right upper jaw being more enlarged than the left, and the lower margin of the right orbit at a lower level than the left. 2607

From a female subject in the dissecting-room, probably affected with osteitis deformans.



**653.** A cast of the base of the brain from the foregoing case, showing flattening of the parts corresponding with the eminences of the interior of the skull, notably of the frontal lobes and the cerebellum.

**653 A.** A plaster cast of the calvaria from a case of osteitis deformans, showing considerable and symmetrical enlargement. The antero-posterior diameter measures 19.5 cm., the transverse diameter 18 cm., and the circumference 61 cm.

8114

From a man 52 years of age, in whom the symptoms of the disease had existed for 20 years. There was a large round-cell sarcoma in connection with the right hemisphere of the cerebellum. (See Dr. H. A. Robinson, *Trans. Path. Soc.* 1887, vol. xxxviii. p. 262, and Dr. Stephen Mackenzie, '*Illustrated Medical News*,' Sept. 29, 1888, p. 11.)

**654.** A left tibia in sagittal section. The bone presents a marked antero-posterior curvature, the convexity of which is directed forwards. The normal shape of the shaft is lost, the middle part of the crest being replaced by a long fusiform enlargement, and the whole shaft appearing to be compressed laterally. At the upper end of the fusiform enlargement above mentioned the surface of the bone is irregularly excavated. The extremities of the bone are normal.

The section shows that the compact tissue, which is thickened along the concavity of the curve, is in all parts much more porous than natural, the osseous tissue being everywhere marked by longitudinal canals. The medullary canal is enlarged, and the cancellous tissue of the upper extremity is rarefied.

6953

#### ACROMEGALY.

Acromegaly is a rare disease of adult life, characterized by enlargement chiefly of the bones of the face, hands, and feet, associated with some thickening of the soft parts. The enlargement of the face affects chiefly the lower jaw, but to a less extent the margins of the orbits and superciliary ridges, the nose, and the malar bone. The enlarged hands and feet are increased chiefly in width and thickness. The ribs and clavicles may be affected. The osseous tissue is rarefied, and the increase of the bones in size is due to a new formation of spongy tissue. The enlargement of the pituitary body, which is often associated with Acromegaly, is illustrated by a specimen in the Medical Series.

#### LEONTIASIS OSSEA.

Leontiasis is a rare affection, usually occurring in adolescence, characterized by progressive development of masses of spongy new bone in connection with certain bones of the face and sometimes of the cranium. The disease is usually symmetrical, and the superior maxillary bones are, in the first instance at least, most commonly affected.

## TUMOURS OF BONE.

The following tumours are met with in connection with bones :—

## Primary.

## Simple.

1. Enchondroma.
  - a. Non-ossifying (655 *et seq.*).
  - b. Myxo-chondroma (661).
  - c. Ossifying (662 *et seq.*).
2. Osteoma.
  - a. Spongy exostosis (662 *et seq.*).
  - b. Ivory exostosis (685, 686).
3. Fibroma (*see* Diseases of the Jaws and Pharynx).
4. Angioma (*see* Diseases of the Jaws).
5. Hydatid cyst.

## Malignant.

## Sarcoma.

- a. Fibro-sarcoma (687 *et seq.*).
- b. Spindle-cell sarcoma (690 *et seq.*).
- c. Round-cell sarcoma (699 *et seq.*).
- d. Mixed-cell sarcoma.
- e. Ossifying and Chondrifying sarcoma (712 *et seq.*).
- f. Myeloid (730 *et seq.*).

## Secondary.

1. Sarcoma.
  - a. The above varieties (738 *et seq.*).
  - b. Melanotic (741, 742).
2. Carcinoma.
  - a. Sphæroidal-cell (743 *et seq.*).
  - b. Columnar-cell (750).
  - c. Squamous-cell (751, 752).

NOTE.—The Mixed-cell sarcomata of bone are not arranged separately, but are placed, according to the preponderant character of the cells, under Spindle-cell sarcoma or Round-cell sarcoma.

## CARTILAGINOUS TUMOURS—CHONDROMA—ENCHONDROMA.

Cartilaginous tumours occur in several forms.

- a. The simple non-ossifying chondromata, as seen most commonly in the phalanges and metacarpal bones. These are composed of pure hyaline cartilage. They are frequently multiple (657), and grow from the centre of the bone (655, 656). They never ossify, rarely soften, but occasionally calcify in parts (656). They are perfectly innocent, but by their continued growth may produce great deformity (660).
- b. Cartilaginous tumours occasionally grow to a great size from the ribs or bones of the pelvis; these soften in the centre into a fluid resembling mucus (*see* Obstetric Series).
- c. Cartilaginous tumours often grow from the long bones near the line of union of the epiphysis and diaphysis. These commence beneath the periosteum or superficially in the bone; as they grow they ossify: when the whole of the cartilage is ossified growth ceases; this usually occurs first at the base, so that this ceases to grow early and the tumour assumes a pedunculated



form (pedunculated exostosis). The bone formed is always spongy, and at the base the cancellous tissue of the tumour will be found to be continuous with that of the bone from which it is growing, no compact tissue existing at this spot. Many of these tumours ultimately undergo complete ossification, and are then spoken of as *exostoses*. They are covered with a fibrous layer continuous with the periosteum, and a bursa not uncommonly forms in the overlying soft parts. They are most common near the head of the humerus (666), the lower end of the femur (662), and on the ungual phalanx of the great toe (670). They are sometimes hereditary and multiple.

d. Tumours of bone consisting of cartilage mixed with sarcomatous tissue (chondrifying sarcoma) are included in a separate series (p. 156).

- 655.** A finger, removed by amputation through the metacarpo-phalangeal articulation. Springing by a broad base from the palmar aspect of the first phalanx is a globular cartilaginous tumour marked out into small lobules by intersecting lines of areolar tissue, which lines are in many situations the seats of earthy deposit. The growth passes deeply within the phalanx, from the cancellous tissue of which it has possibly arisen; its limit in this situation is not recognizable. A thin fibrous investment, continuous with the periosteum, is spread over the projecting part of the tumour. Both the articular ends of the bones are unaffected. 5336

From a girl, 15 years of age, who, when six years old, fell and injured her finger. The tumour appeared soon after the injury.

- 656.** A finger, with the distal half of its metacarpal bone. Attached to the head of the metacarpal bone, and arising within it, is an oval tumour about 2.5 cm. and 5 cm. in its chief diameters, and composed of firm, semitransparent, homogeneous cartilage, variously intersected with lines of white fibrous tissue. On the surface of the tumour is a thin incomplete layer of osseous tissue resulting from the expansion of the end of the metacarpal bone. Many points of calcification, following in places the imperfect fibrous partitions, are scattered through it. 3758

From a boy 9 years old. The tumour appeared when he was two years of age, and is said to have followed a blow. There were in all eight such tumours on the two hands, all of which were said to have grown after blows.

- 657.** Two fingers, with the corresponding metacarpal bones. In one finger each phalanx is the seat of one or more cartilaginous tumours, that on the last phalanx springing from its palmar aspect; the several tumours have lowly nodular surfaces, and are covered with a glistening membrane, the deeper part of which is continuous with the periosteum; the metacarpal bone is swollen out on one side by extension of the growth within. In the other finger the tumours are confined to the first phalanx and metacarpal bone. 3746

- 658.** A right middle finger, removed by amputation through the metacarpal bone. All the phalanges and the metacarpal bone are the seat of cartilaginous tumours. The first and second phalanges are greatly enlarged, especially in their proximal halves, by the growth of cartilaginous tumours in their interior. Very little unaltered bone remains, the cartilaginous growth having a translucent grey appearance, and being intersected with fine lines of fibrous tissue and small yellow patches of calcareous deposit. In the ungual phalanx a small cartilaginous growth projects from the palmar surface of the proximal half and involves the cartilaginous surface. Two separate cartilaginous growths occupy the interior of the metacarpal bone, one lying immediately beneath the articular cartilage. The joints are unaffected, although their surfaces are altered in shape by the cartilaginous growth beneath the articular cartilage. 5569.

Removed by amputation from a boy aged 19. (Surg. Reg. Report, 1881, p. 52, No. 1328.)

659. A plaster cast of a right hand, the first phalanx of the index finger of which was the seat of two enchondromatous tumours, one of them projecting for 3 cm. from its radial surface, and measuring about 4 cm. across its base; the second, much smaller, presses into the cleft between the index and middle fingers.

660. Plaster cast of a right hand, greatly deformed by massive enchondromatous growths, considerably exceeding in size the hand itself. The largest of the growths, slightly lobed, oval, and measuring about 10.5 cm. by 7 cm., occupies the whole of the dorsum, and has apparently sprung from the middle metacarpal bone. In the position of all the phalanges, except the ungual, of the ring and little fingers are large pyriform or globular swellings, which appear in many places to have coalesced one with another and form one deeply cleft or clustered mass.

661. The inner half of the lower third of a right femur, which is the seat of a cartilaginous tumour. The growth occupies the interior of the bone in its lowest 6 cm. Posteriorly it projects through an opening in the compact tissue in the form of a rounded mass above the condyles. Anteriorly the tumour has produced a perforation smaller than that behind, and situated immediately above the patellar surface; through this opening the central part of the growth is continuous with a large lobulated mass which overlaps the anterior and internal surfaces of the shaft to the extent of 8 cm. The section through the central part of the growth, as well as of that which projects posteriorly, presents a greyish-white semitranslucent appearance, the surface being marked by opaque white lines of fibrous tissue. The part of the growth which projects in front is extensively cystic, the most superficial cysts producing the lobulation of the surface of the tumour. In the recent state the cysts contained clear fluid and granules of solid matter.

7313.

*Microscopic Structure.*—The tumour is a myxo-chondroma. Between the lobules of cartilage and myxomatous tissue are strands of delicate connective tissue rich in spindle-shaped cells. Some of the softer lobes of the tumour consist of pure myxomatous tissue.

Miss J., aged 20, was under the care of Mr. Heath in Nov. 1894. The lower end of the right femur was enlarged, and egg-shell crackling could be felt. The case was seen in consultation with Lord Lister, and the diagnosis of myeloid sarcoma was made. Amputation was performed. The patient was in good health and free from any evidence of recurrence nearly four years later.

#### OSSEOUS TUMOURS OF BONE—EXOSTOSIS.

There are two varieties of exostosis.

(a) The *spongy, cancellous, or pedunculated exostosis*. This has already been described as the ossifying enchondroma (see p. 141).

(b) The *ivory exostosis*, so called from its intense density. This is composed of true bone, but the Haversian canals are very few and small. It is most common about the bones of the skull and lower jaw (685, 686).

(a) *The osseous tissue chiefly cancellous. "Pedunculated exostosis,"*  
*"Cauliflower exostosis," "Ossifying enchondroma."*

662. The anterior half of the lower part of a right femur, on the inner aspect of which, at a distance of 5 cm. above the epiphysial line, is a pedunculated club-shaped exostosis. The bulk of the tumour is composed of cancellous bone continuous, through the pedicle, with that of the shaft. Over this is a layer of compact bone, whilst the extremity of the tumour is capped with a layer of cartilage. A portion of the fibrous capsule which covered the tumour remains on the upper surface of the pedicle.

6465

From a boy aged 18, who died of heart disease.



**663.** The lower third of a left femur, attached to the front of which, close above the outer border of the patellar surface, is a small, slightly pedunculated, osseous tumour, the summit of which was probably encrusted with cartilage. There is a layer of dense new bone nearly covering the patellar surface of the femur, formed probably as a result of rheumatoid arthritis. 3058

**664.** The upper half of the left tibia of a young subject, to the posterior wall of which, a short distance below the epiphysis, is attached a small, flask-shaped, cancellous, osseous tumour. The tumour arises by a flattened elongated pedicle, and is directed almost vertically downwards; its summit exactly resembles the ossifying surface of the epiphysis of a long bone, and was probably furnished with a thin cartilaginous covering.

**665.** A section of a spongy exostosis removed by operation. The pedicle is indicated merely by a shallow groove on the surface. The extremity is covered with a thick layer of cartilage, which in the recent state was almost jelly-like; over this is a fibrous capsule continuous with the periosteum.

**666.** A section of a spongy exostosis removed by operation. The tumour, which is composed of cancellous tissue covered with a thin layer of compact bone, has a lobulated shape. One small prominent lobule is covered with cartilage, and beneath it the main growth contains two cysts, the upper and larger of which has evidently arisen from the coalescence of smaller spaces. The periosteum is continuous over the surface of the tumour. 5912

The tumour was removed by Mr. Godlee from the upper end of the humerus of a boy aged 11.

**667.** An oval osseous tumour, measuring about 4 cm. in its chief diameter, with the adjoining portion of the upper part of the shaft of the humerus, to which it was attached by a broad base. Over its most prominent part it is covered with a thin layer of cartilage, which varies in thickness from the unequal advance of ossification into it. The rest of the tumour is made up of cancellous tissue very open in the centre; the parts of the tumour not covered by cartilage are closed in by a thin layer of firm compact bone. Parallel to this tumour is a similar elongated, though much smaller and less prominent, growth. The compact tissue of the shaft of the humerus beneath the tumour has undergone absorption, the cancellous tissue of the tumour being continuous with that of the bone. It is this condition that has caused these tumours sometimes to be inaccurately spoken of as "outgrowths of the cancellous tissue."

**668.** The last phalanx of a great toe, with the investing soft parts. From one of its sides a bony tumour has grown, and forms a rounded, somewhat pedunculated, projection by the side of the nail. The growth is overlaid with a cracked, glistening, laminated, horny layer formed from the matrix which covers it. 3747

The parts were removed by amputation.

**669.** The distal phalanx of a great toe, with some of the investing soft parts. From its dorsal surface there projects, somewhat to one side, an osseous growth which has turned back the nail, and is itself covered with a horny cap formed from the stretched and displaced matrix which invests it. 3528

From a patient 19 years of age. The disease was attributed to an injury received two years previously.

**670.** The ungual phalanx of a great toe, with some of the investing soft parts. To its dorsal surface there is attached by a constricted base a small globular tumour, composed of delicate cancellous bone capped with cartilage into which ossification is advancing. By the growth of the tumour the nail has been bent backwards, and, where not overlapped by this, the tumour is covered only by the matrix stretched over it. 3679

The part was removed by amputation.

671. The ungual phalanx of a great toe, together with the nail, in section. From the dorsal surface of the distal half of the bone an osseous growth projects through a rounded opening in the nail, which is cracked and irregular and raised around the pedicle of the tumour. The summit of the tumour is composed of cartilage, the vascular growing bone beneath which has been coloured with carmine. The matrix covering the tumour is ulcerated. 6160

The ungual phalanx, together with the tumour, was removed from a boy aged 13. For 4 months there had been all the signs of ingrowing toe-nail. (Mr. Hill's *Case-books*, 1886, vol. ii. p. 58.)

672. The terminal phalanx of a great toe, upon the upper surface of which, slightly to one side of the middle line, is a low, truncated, bony tumour, the summit of which presents an open, finely cancellous structure. The surface was probably coated with cartilage, into which ossification was extending. 3276

673. Half of an oval exostosis, measuring 2.5 cm. in its longer diameter. The surface of the tumour is covered with a fibrous capsule, beneath which, over its most prominent part, is a thick layer of cartilage. 5887

674. An oval osseous tumour, measuring 2 cm. in its longer diameter; it is composed of closely cancellous bone, covered superficially with a thick layer of cartilage, in the deepest part of which are small opaque areas of calcification. 5417

675. The upper end of a left femur. Attached to the posterior surface of the neck is an irregular mass of bone, which overhangs its base of attachment and has become connected on its outer side with the great trochanter; its inner border projects half over the posterior surface of the head, from which it is separated by a deep angular groove in adaptation to the margin of the acetabulum. 4279

676. A longitudinal section of the upper part of a left femur, around the neck of which an osseous tumour has grown, so as to form a great projecting irregular mass. The tumour is formed throughout by light cancellous tissue with fine rods and lamellæ set widely apart, so as to leave large spaces between them, and closed in with a thin compact layer, which accurately follows the irregularities of its surface. The compact wall of the neck of the femur has disappeared, the cancellous tissue of its interior being indistinguishably continuous with that of the morbid growth around it.

677. An osseous tumour, removed from the lower third of the shaft of the femur, to which it was attached by a stunted narrow pedicle. The tumour forms a branching cauliflower-like mass of closely cancellated bone spread over a distance of about 7 cm., and projecting about 6 cm. from the attached surface. Irregularly distributed through the growth are numerous grey semitranslucent areas of cartilage. 3864

678. Plaster cast of the right knee and adjoining parts of the limb of the patient from whom the preceding specimen was taken. 4683

The following is an account of the condition of the parts before the operation:—"At the inner side of the lower end of the femur is a tumour, hard, painless, with an irregular surface, immovable, of somewhat pyramidal shape, about the size of the fist, having its long diameter in the direction of the limb, but with some degree of obliquity, its lower end being inclined towards the popliteal space under the muscles which bound it on the inner side, while the upper is directed forwards upon the anterior aspect of the bone. The tumour is apparently free of the knee-joint; the femur has its natural shape and does not blend in any way with the diseased mass. The surrounding parts and lymphatic glands in the groin are unaffected." The patient was a lady of nervous temperament, 26 years of age. Her general health was good, and there was no hereditary taint. The tumour was of slow growth; the compact wall of the femur was continued on its pedicle, so that in the removal of the growth the cancellated structure of the femur was laid bare. (Med. Times, No. 524, vol. xx., Oct. 13, 1849, and Quain's *Clinical Lectures*, 1884, p. 25.)



**679.** A sagittal section of a right knee-joint. The lower end of the femur is surrounded by a lobed mass of osseous tissue, with which the patella is almost indistinguishably blended, the line of its anterior surface and upper border, with the extensor muscles inserted into it, alone remaining recognizable. The surrounding mass is readily separable from the bones (except the patella) upon which it rests, and is itself divided into three or more closely adapted, yet readily separable, portions, held together only by loose connective tissue. The morbid growth has in places encroached upon the articular space, and has partly buried itself anteriorly in the wall of the femur; inferiorly it extends for a short distance upon the tibia. The tumour is composed throughout of cancellous osseous substance, the meshes of which are filled with medulla; but in the deepest part of the globular mass situated on the back of the joint a few semitransparent greyish areas of cartilage are discernible, and the osseous portion of this part of the growth is composed of mutually adapted, separable, lobe-like pieces. 5384

**680.** The other half of the same knee-joint, dried.

**681.** A plaster cast of a large exostosis, which was removed by operation from the inner surface of the skull in the right frontal region. It is irregular in shape, and its longest measurement is nearly 5 cm. The tumour is preserved in the Museum of the R. C. S. 6324

From a man, aged 20, who suffered from neuralgic headache and pain in the right eyeball, with a sensation of "the brain feeling heavy." He had had epileptic fits on the left side. The right eyeball was prominent, and a hard oval swelling could be felt at the upper and inner part of the orbit. Operation by Mr. Horsley:—An incision was made along the superciliary ridge and the frontal bone trephined. The tumour, which projected into the frontal sinus and pressed the dura mater inwards, was removed by cutting through the bone around its base. A wound in the dura mater was closed with sutures. The fits were arrested, and for some years the patient was well, but afterwards mental changes slowly supervened. ('Practitioner,' May, 1899.)

**682.** A left clavicle, to the inferior surface of which, 1 cm. internal to the conoid tubercle, is attached a small, slightly pedunculated, osseous tumour. The pedicle is broad, and the under surface of the tumour is flattened. The posterior lip of the groove for the subclavius muscle is unduly prominent and continuous with the tumour. 3204

**683.** A pedunculated oval tumour bisected, measuring nearly 4 cm. in its longer diameter. The pedicle, through which the tumour has been removed, measures 2 cm. by 1 cm. The growth is composed of dense cancellous bone, surrounded by a layer of compact bone, except over the flattened surface of the tumour, which is covered with a layer of cartilage measuring 5 mm. at the thickest part. The line of junction of the bone and cartilage is very undulating, and at its margin the cartilage projects in small rounded lobules. The periosteum is continued as a dense fibrous layer on the surface of the pedicle. 8006

The tumour was removed by Mr. Pollard from the left scapula of a girl aged 17, whose shoulder had been noticed to be growing out for some months. The tumour was attached to the ventral surface of the bone, close to the vertebral border.

**684.** Part of a right hip-bone, from the inner surface of which, close to the anterior superior iliac spine, a slightly pedunculated osseous tumour has grown. The tumour is irregularly lobulated, and in its central part projects to the extent of 4 cm. One prominent oval lobule overhangs the anterior part of the iliac crest. 7535

From a patient who died of meningitis.

(b) *The osseous tissue chiefly compact.*

**685.** Part of a frontal bone, upon which are seated three lenticular osseous tumours ranged in vertical series on the left of the middle line of the bone. Each of the tumours is about 1 cm. in diameter, and of densely compact, ivory-like

structure, which contrasts with the compact surface of the bone around; the borders of the lowest two are slightly overhanging; the other is sessile. On the right of the lowest tumour are two small, slightly raised, porcellaneous patches, and numerous minute spots of a similar character are present on other parts of the frontal bone. 4986

686. The posterior part of a skull. Upon the occipital bone, on the right side and above the upper curved line, is a limpet-shaped osseous tumour which measures about 3.5 cm. across its base; its exterior is smooth, dense, and perforated, with but few visible vascular channels. 5412

### FIBROUS TUMOURS OF BONE.

These are composed of dense white fibrous tissue; they are tough, opaque white in colour, and often lobulated; on section they often present a glistening striated appearance, produced by the bundles of fibrous tissue. Fibrous tumours of bone almost always commence in connection with the periosteum, enveloping the bone and partly destroying it by pressure; less commonly they arise within the bone and expand it over them. Fibromata are rarely met with in the long bones of the extremities. They are more common in the jaws, and when growing from the alveolar border produce the disease known as *fibrous epulis* (see Diseases of the Jaws). A very vascular form of fibrous tumour grows occasionally from the basilar portion of the occipital bone and the body of the sphenoid, forming the *fibrous polypus of the pharynx* (see Diseases of the Pharynx). Fibrous tumours of bone, if imperfectly removed, may recur in a softer, more cellular form, which assumes the features of a sarcoma.

### FIBRO-SARCOMATA OF BONE.

These tumours are composed chiefly of fibrous tissue, but between the fibres are numerous young cells, round or oat-shaped. They most often commence beneath the periosteum. They closely resemble simple fibromata in appearance.

687. A longitudinal section of the upper two-thirds of a right humerus, and a firm lobulated tumour which has grown upon it. The upper limit of the tumour is about 5 cm. below the neck of the bone; and the growth itself measures about 9 cm. between its upper and lower ends, and projects about 4 cm. from the subjacent surface. A layer of new bone has been formed beneath the growth, and the medullary canal of the humerus is occupied for a corresponding distance with similar osseous substance.

*Microscopic Structure.*—The tumour is composed mainly of spindle-cells mixed with a large amount of fibrous tissue.

From a woman, 19 years of age, admitted under Mr. Marshall's care, June 1875.

In June of the preceding year she was riding in an open carriage; the horse reared, and to save herself from falling out the patient caught hold violently of the back of the seat with her left hand, and believes she strained her arm. Within a fortnight from that time, on touching her left arm she found she had a tender swelling, about the size of the top of the thumb, on the inner side of the arm. As the tumour continued to grow it became spontaneously painful, the pain shooting down the arm; during the three months prior to her admission the growth of the tumour was very rapid, and the patient expressed herself as feeling weaker. Her family history was good.

The limb was removed by amputation through the shoulder-joint. The patient was discharged well in August. (Mr. Marshall's *Case-book*, 1875, p. 225.)

688. A vertical section of part of the shaft of a femur and of a tumour which has grown within it. The tumour has expanded the bone for a distance of 10 cm. and at its broadest part measures 8 cm. across. The growth is entirely



endosteal, and its surface is almost everywhere covered by a layer of bone continuous with the compact tissue of the shaft. The expanded bone varies much in thickness, but in most parts is thin enough to be indented by moderate pressure with the finger. A thick fibrous layer continuous with the periosteum covers the expanded bone, and at the upper and lower limits of the growth a thin layer of new bone has been formed on the surface of the shaft. The section shows that the tumour has but very loose connections with the shell of bone within which it lies, so that the outline of the growth is at all parts very clearly defined. In its present condition the tumour is of a yellowish-white colour and close texture.

5613

*Microscopic Structure.*—The tumour is a fibro-sarcoma; it consists of an abundant stroma composed almost entirely of dense white fibrous tissue. In this are contained small groups and lines of irregularly rounded cells, which in parts are intimately intermixed with the stroma, but in other parts form sharply defined groups. A few bony spicules are scattered through the growth.

689. The outer half of a right foot, from the dorsum of which there projects a large globular, firm tumour, which has arisen, apparently, in connection with the metatarsal bones and extends for a short distance into the sole. The section shows the tumour to be composed of dense fibrous tissue, in places arranged in glistening bands which imperfectly partition the mass into lobes; its outline is everywhere traceable. Over the most prominent part of the growth the skin has been removed by sloughing or ulceration, and through the apertures in it part of the tumour projects with a shreddy fungating surface.

3750

*Microscopic Structure.*—The tumour is a fibro-sarcoma. It consists of loose fibrous tissue containing an abundance of small spindle-cells.

The specimen was presented by Mr. Syme, and in the MS. Catalogue is described as a "soft cancer."

#### SPINDLE-CELL SARCOMATA OF BONE.

These form a very large proportion of the malignant tumours of bone. They are composed of spindle-shaped cells, often of great length and size. Each cell contains one or perhaps two oval nuclei. Between the cells is a small quantity of homogeneous intercellular substance. These tumours are very vascular. They arise frequently beneath the periosteum of long bones at some part of the shaft (691, 692). The bone is destroyed to a greater or less extent by the invasion of its structure by the cells of the tumour. The compact tissue may thus be perforated, and the tumour may then grow rapidly in the medullary canal. Spontaneous fracture may occur as a consequence of this invasion of the bone (691, 692). Occasionally spindle-cell sarcomata commence in the medullary canal. They form the most frequent variety of malignant tumour of the bones of the face. They are soft and brittle in texture; in colour they vary; the growing margin is pink, the central parts are often yellow from fatty degeneration; patches of hæmorrhage are not uncommon, and cysts are of occasional occurrence. In rare cases they are so vascular that pulsation is clearly to be felt, and occasionally the structure may be so broken down by hæmorrhage that the whole growth may resemble a blood-clot. These have been described as blood-cysts of bone, or osteo-aneurism. Spindle-cell sarcomata are usually very malignant, recurring in the lungs and liver, but not affecting the lymphatic glands.

Specimens of spindle-cell sarcoma of the jaws are preserved in the series Diseases of the Jaws."

690. The lower part of a skull, with the bones of the face and some of the adjacent soft parts. Occupying the left orbit, and projecting beyond so as to overlap its margin, is a lobulated mass of firm sarcomatous substance. On the right side

a similar growth, arising apparently from the periosteum, fills the temporal and zygomatic fossæ, surrounds the ear, and spreads inwards beneath the base of the skull as far as the margin of the foramen magnum, and forwards to the posterior nares; the zygoma and the malar bone lie embedded in the growth. The skin around the ear is covered with prominent, closely-set, warty growths. A small oval mass of similar tumour-substance has grown from the dura mater, with which it has been detached from the base of the petrous portion of the temporal bone; the surface of the latter, corresponding with the seat of the tumour, is deeply and irregularly pitted. 4272

Microscopic examination of the tumours removed at the first and second operations showed the growth to be a large spindle-cell sarcoma.

The patient, a delicate girl, had a tumour removed from the orbit by Mr. Quain. The tumour had existed only two months, but from its rapid progress was believed to be malignant. A fortnight after the operation a second growth appeared beneath the upper eyelid, and at the end of two months had grown so rapidly as to require a second operation. A third tumour afterwards appeared below the outer canthus and was removed by a third operation, when it was found to reach the very bottom of the orbit. All this while the child's health did not in the least deteriorate, but on the contrary she grew fat and hearty. Some weeks later, with the growth of the tumour shown in the preparation, she began to lose flesh, became weaker and weaker, and died.

691. A right femur, which has been divided by a sagittal section. Surrounding the shaft for almost its upper two-thirds is a long fusiform tumour, which at its most prominent part is raised about 3 cm. from the subjacent surface. The medullary canal, for a length equal to that of the tumour, is occupied by a similar morbid substance, and the compact wall of the shaft between has in one situation been so deeply invaded by the growth that the femur has been here spontaneously fractured; where the bone is broken the Haversian canals are enlarged and filled with a substance resembling that composing the tumour. The tumour is formed by a soft basis-substance, which in the recent state was of a brownish-red colour, traversed and sustained by a fine meshwork of most delicate areolar tissue, and partitioned imperfectly into lobes and columns by denser fibrous lamellæ which pass between the periosteum investing the growth and the surface of the shaft of the bone; its fibrous investment is in parts inseparably blended with the fibres of the vastus internus.

*Microscopic Structure.*—The tumour is a large spindle-cell sarcoma.

The patient, A. W., aged 27, was admitted into U. O. H. in 1865, under the care of Sir John Erichsen. He had a large fusiform, elastic, almost fluctuating swelling in the right thigh; it gave but little pain, and had been slowly growing for some months, but had of late increased more rapidly in size. A grooved needle inserted into the softest part drew nothing but blood. There was no enlargement of the lymphatic glands. The diagnosis being somewhat doubtful, the patient was kept in the hospital and watched. One day, whilst getting out of bed, he fractured the femur, and the diagnosis of malignant tumour was at once made. Amputation at the hip-joint was performed, and the patient partially recovered. He was able to leave the hospital, but the wound never completely healed, and he died a few months afterwards with recurrence at the seat of operation and probably also in internal organs.

692. A vertical section of a left femur, patella, and upper part of the tibia, and of a large subperiosteal tumour growing from the shaft of the femur. Anteriorly the tumour extends from the level of the small trochanter to the upper border of the patella, and projects to the extent of 10 cm. from the subjacent surface of the shaft. This part of the growth has been so extensively broken down, probably as the result of hæmorrhages into its substance, that it appears only as a thick fibrous sac, the inner surface of which is at its upper and lower ends smooth; but for the rest of its extent it is lined with large, irregular, shreddy masses of tumour-substance, and with layers of laminated matter probably derived from altered blood-clot. A thick layer of granular tumour-substance covers the anterior surface of the bone.

Posteriorly the growth extends from a point 8 cm. below the small trochanter



to the lower extremity of the bone. In this situation the growth is for the most part of a close even texture, and has a maximum thickness of 3 cm.

The femur is fractured in two places, at a distance of 10 cm. below the small trochanter and again 12 cm. lower down. From the inferior epiphysial line to a level 4 cm. above the upper of the two fractures the medullary canal is filled with new growth, which has caused extensive destruction of the compact tissue in the neighbourhood of the lower fracture. The growth which fills the medullary canal between the situation of the two fractures is freely mixed with newly-formed bone. The anterior compact wall of the shaft can be traced continuously through the growth, and especially in the neighbourhood of the lower fracture it is thinned and eroded. The posterior compact wall is thickened by a deposit of new bone on its outer surface, and the line of demarcation between it and the superjacent growth is ill-defined. 6328

*Microscopic Structure.*—A sarcoma composed of very large spindle-cells.

From a girl, aged 16, in whom the disease had been noticed 6 months, and who had been treated by a herbalist. The thigh was enormously enlarged, chiefly as a result of the cysts in the tumour, which together contained 10 pints of blood-stained fluid. Disarticulation at the hip-joint was performed by Mr. Heath; a short anterior flap was raised by dissection, and after the head of the bone had been disarticulated a long posterior flap was cut from within outwards: the circulation was controlled by an aortic tourniquet. The patient was discharged on the 42nd day, and died a few months after leaving the hospital. (Surg. Reg. Rep. 1887, p. 200.)

693. The lower part of a right femur, together with a tumour involving the outer half of its lower extremity, in vertical section. The tumour, which has an irregularly rounded outline and finely lobulated surface, corresponds very accurately at its lower border with the edge of the articular cartilage of the external condyle. In front it reaches nearly to the middle line and behind slightly beyond it, and at its upper border extends 3.5 cm. above the patellar surface. The outer head of the gastrocnemius is incorporated with the substance of the tumour. The compact tissue of the femur around the margin of the tumour shows no evidence of expansion, but the section shows that it is destroyed beneath the growth, which extends deeply into the cancellous tissue of the extremity of the bone. 6365

*Microscopic Structure.*—The growth is a spindle-cell sarcoma.

From a woman, aged 40, admitted into U. C. H. under the care of Mr. Beek in May 1888. There had been swelling of the right knee for six months; at first it was painless. The swelling was limited to the outer part of the lower extremity of the femur; its nature having been determined by an exploratory incision, amputation was performed below the middle of the thigh.

694. The lower part of a left femur in coronal section. Occupying the outer half of the lower extremity is a tumour extending in front and behind to the middle line of the bone, reaching downwards to the margin of the articular cartilage of the outer condyle, which in parts it slightly overlaps, and upwards for 4 cm. above the patellar surface. The surface of the tumour is slightly lobulated and has no bone covering it. On the cut surface the tumour is seen to reach to the middle of the cancellous tissue, whilst the compact bone has been destroyed to an extent of 5 cm., its lowest remaining part being for a short distance overlapped by the growth, and not expanded over it. The cut surface of the tumour presents to the naked eye a distinctly fibrous appearance. 6805

*Microscopic Structure.*—The tumour is a mixed-cell sarcoma, the greater number of the cells being oval or spindle-shaped. The stroma is abundant and homogeneous.

M. E., a woman aged 21, was admitted into U. C. H., under the care of Mr. Beek, on January 1, 1892. Six months before she twisted the left knee whilst rising from a kneeling position. A few weeks later swelling and pain in the knee were first noticed. On admission there was enlargement of the outer part of the lower extremity of the femur, which an exploratory incision proved to be due to a solid growth. On January 9 amputation was performed, the femur being divided 7½ inches above the condyles. Discharged February 2. (Mr. Beek's Case-books, 1892, vol. ii. p. 465.)

695. A section of the upper half of a right tibia and of a tumour by which it is almost surrounded, together with the corresponding part of the fibula. The growth, which measures about 15 cm. in length, has passed through the upper part of the interosseous space, and is firmly attached to the adjoining part of the outer surface of the tibia; lower down the interosseous membrane is tensely stretched upon it. The fibula lies in a deep groove in the outer and posterior surface of the tumour. The section shows the tumour to extend deeply into the medullary canal and into the cancellous tissue of the head of the tibia, within which it has probably arisen; inferiorly its limit in this situation is ill-defined; in the rest of its extent its outline is uneven or undulating, and the tumour-substance rests upon the consolidated bone around. In the head of the tibia, near its anterior border and about 3 cm. below the articular surface, is a circular mass (in the plane of section discontinuous with the main tumour) having a somewhat loose shreddy surface exactly resembling that of the part of the tumour lying near it. Through the substance of the tumour are scattered many smooth-walled cysts, varying from the smallest size perceptible to 2.5 cm. in diameter; one of the largest of these is situated at the deepest part of the tumour, where its anterior wall is formed by so thin a layer of tumour-substance as to be scarcely recognizable. 3752

*Microscopic Structure.*—The growth is a mixed round- and spindle-cell sarcoma.

The specimen was presented by Mr. Syme, and the tumour is described in the MS. Catalogue as a "soft cancer."

696. The outer half of the upper part of a left tibia and of a tumour growing from it. The tumour covers the posterior aspect of the bone for a distance of 8 cm. below the articular surface, and projects as a lobulated mass to the extent of 4 cm. from the surface of the bone. The section shows that the posterior compact wall of the head of the bone has been destroyed for 2 cm. below the cartilage, and that the interior of the bone is occupied by growth to an extent equal to that of the tumour externally. The articular cartilage covering the external tuberosity is normal. In its present condition the growth has a pale rusty-brown colour and friable consistence.

*Microscopic Structure.*—The tumour consists for the most part of large cells varying much in shape, and irregularly intersected by fasciculi of spindle-shaped cells. In some parts of the section so many multinucleated cells are present as almost to warrant the inclusion of the specimen among the myeloid sarcomata.

From a woman, aged 20, who had noticed the swelling for four months. Amputation through the condyles of the femur was performed by Mr. Stonham. The other half of the tumour is in the Westminster Hospital Museum.

697. The anterior half of the upper part of a right humerus and of a sarcomatous tumour growing from it. A fracture has taken place through the surgical neck, and the separated head has been displaced downwards on the inner surface of the shaft. The tumour forms a rounded projection on the outer aspect of the shaft, and is continuous, above its fractured extremity, with the separated head. The compact tissue of the shaft is readily traceable upwards to the fractured surface, and has not undergone expansion. The tumour is surrounded by a distinct capsule, which is in front formed by the fibres of the deltoid muscle stretched over it. 7062

*Microscopic Structure.*—The tumour is a mixed-cell sarcoma, in which the spindle-cells largely predominate. Muscle-fibres are seen in the substance of the growth.

698. The lower two-thirds of a right femur, with the upper ends of the bones of the leg, patella, &c. The femur is, for its lower 15 cm., encircled by a great lobulated sarcomatous tumour, which covers the patellar surface and has grown inwards so as to cover the flattened part of the articular surfaces of the condyles; the knee-joint is flexed to a right angle. The articular



cartilage, where overlapped by the growth, has in part been absorbed, and the cancellous spaces and medullary canal of the femur, to within a short distance of the upper end of the tumour, are filled with a new growth which, close above the patellar surface, is directly continuous with the mass without, the compact wall of the femur having been here entirely replaced by the substance of the tumour. The divided surface of the tumour is almost everywhere homogeneous and brain-like; but in places it is pale grey from hæmorrhage, and in one or two situations presents irregular cyst-like spaces, the result, probably, of hæmorrhagic effusions. The tumour has probably grown from beneath the periosteum, which is continued over it.

*Microscopic Structure.*—The tumour is a large spindle-cell sarcoma.

### ROUND-CELL SARCOMATA OF BONE.

These are composed of small round cells, somewhat resembling lymph-corpuscles, separated by a small quantity of homogeneous intercellular substance, or in some cases by an alveolar stroma of fibrous tissue. They are extremely vascular, and may pulsate freely. They usually begin beneath the periosteum and surround the bone, but they may arise in the medullary canal. They are common in the femur, tibia, and bones of the face. They are extremely soft, and white and brain-like in appearance (699). Cysts may be present. They are very malignant in their course, invading surrounding structures and recurring in the internal organs (701, 702).

**699.** The lower part of a right femur, the end of the shaft of which is, for a distance of about 12 cm., surrounded by a superficially lobed tumour of white, homogeneous, brain-like substance. The interior of the bone, as far as the highest part of the growth, is occupied by similar brain-like substance, which contrasts markedly with the natural medulla above; but the limit between the two is ill-defined, the one seeming to be continued into the other. In the plane of section the compact wall of the femur is everywhere traceable; the mass of the tumour is invested with periosteum, from the deep layer of which it has doubtless grown. 4579

*Microscopic Structure.*—The tumour consists of small round cells, with which are mixed a few fat-globules and some granular matter.

The parts were removed by amputation from a man 27 years of age. It was believed that an aunt had died of cancer; no other hereditary taint could be traced. The patient had four delicate children. The disease began to show itself about four months prior to the operation, in pain and stiffness of the knee, which the patient attributed to a slight blow. During the two months preceding the operation he had been confined to bed and unable to sleep without large doses of morphia; he was much emaciated and subject to copious night sweats; pulse from 100 to 130. The swelling, which varied in its shape from time to time, did not extend into or alter the form of the knee-joint, and it was everywhere, though not uniformly, elastic; the knee was flexed to a right angle. The seat of greatest pain (chiefly nocturnal) and tenderness varied. After removal the tumour was found to consist of various semifluid masses connected by septa. The patient rapidly progressed towards recovery after the first fortnight, and a year afterwards was strong and robust.

**700.** A vertical section of a right knee-joint, together with the surrounding soft parts, and a sarcomatous tumour which has grown from the patella. On the anterior aspect of the limb the tumour protrudes through an opening in the skin in the form of a lobulated mass measuring 9 cm. vertically. The surface of the mass presents black and brown patches, probably resulting from altered blood-pigment and dried epidermis. The skin around the base of the protruding growth is evidently infiltrated, being slightly raised and less wrinkled than the healthy skin around. On the surface of the section, the protruding portion of the growth presents in parts a yellowish-white, almost brain-like appearance, but scattered through it are brownish areas and a large group of almost black spots, the result of alterations in extravasated blood. This part of the growth is

definitely limited in its deep aspect by the remains of the aponeurotic expansion on the front of the patella. No part of the latter, with the exception of its cartilaginous surface, is recognizable, but its place is occupied by a deeper portion of the growth having characters similar to those above described. The vertical measurement of the growth considerably exceeds that of the normal patella, especially below, where it reaches to the tubercle of the tibia. The knee-joint is not involved, and the portions of the femur and tibia displayed in the section are healthy. 5434

*Microscopic Structure.*—The growth consists of round and spindle cells.

The patient, a woman aged 63, was under the care of Mr. Lane in St. Mary's Hospital. Symptoms began three months before admission. The knee-joint was distended, and the soft elastic growth simulated effusion into the prepatellar bursa. This was aspirated and afterwards incised. The growth then began to fungate and copious hæmorrhage occurred. The nature of the disease being recognized, the limb was successfully removed.

(The other half of the specimen is No. 340 in St. Mary's Hospital Museum.)

701. The upper half of a left femur, together with a sarcomatous tumour surrounding it. The growth has a lobulated surface and in the recent state was very soft in consistence; it surrounds the bone from the neck downwards for a distance of 12 cm. The outlines of the great trochanter are unaltered. 7296

*Microscopic Structure.*—The tumour is a small round-cell sarcoma. The masses of cell-elements are large and line the meshes of a fibrous stroma.

From a girl aged 16, under the care of Mr. Heath in U. C. H., in 1894. There had been stiffness and aching pain in the limb for two months, and swelling of the thigh had been noticed for two months. Amputation was performed at the hip-joint by an anterior flap raised by dissection and a posterior flap cut from within outwards after disarticulation. Part of the anterior flap sloughed and secondary hæmorrhage occurred on the 26th day, and was arrested by plugging; bleeding did not recur. Death occurred on the 73rd day after the operation; there was extensive recurrence in the stump; both lungs contained secondary deposits; a large psoas abscess on the left side reached up nearly to the diaphragm.

(See Surgical Registrar's Report, 1894, pp. 52 & 80, No. 1751.)

702. The tibia and fibula of a left leg, together with a sarcomatous tumour partly surrounding their upper extremities. The growth forms an irregular lobulated mass which fills the upper part of the interosseous space, projecting between the bones in front and behind for a vertical distance of 10 cm. The fibula lies in a deep groove on the outer surface of the tumour, whilst on the inner side the upper part of the growth encroaches on the tibia both from the back and front, leaving a free interval of about 2 cm. on the surface of the bone. Except on the inner side, the upper limit of the growth has been cut through in the removal of the limb through the knee-joint. In the lower part of the front of the tumour an opening leads into a large irregular central cavity. 6164

*Microscopic Structure.*—The growth consists of round cells in a homogeneous matrix.

From a woman aged 22, under the care of Mr. Heath in U. C. H., in Dec. 1885. Her mother had died of cancer. For 3 or 4 months there had been soreness and swelling about the right knee, which was painted with iodine. On admission there was swelling at the upper part of the left leg, between the tibia and fibula, extending to 6 inches below the patella and a second swelling over the inner tuberosity of the tibia. The nature of the tumour having been determined by an exploratory incision, amputation was performed through the condyles of the femur. The limb was first removed through the knee-joint, but the presence of growth in both the flaps necessitated the higher amputation. A year later amputation through the upper part of the thigh was performed at another hospital on account of recurrence in the stump. The patient remained well for 8 months, and then serious chest symptoms supervened and she died in 6 weeks. Both lungs were the seats of extensive secondary deposits.

(See Surgical Registrar's Report, 1886, p. 83, No. 2494, 1885.)

703. A left humerus, together with the surrounding muscles and a large sarcomatous tumour invading them, in vertical section. The tumour, which appears to have begun under the periosteum, involves the whole length of the shaft, the centre of which is fractured. The medullary canal is occupied by the growth.



The surface of the shaft is rough, and at almost all parts no trace of the periosteum is recognizable. Below the great tuberosity for a distance of 2.5 cm. the compact bone has been completely destroyed. The tumour, instead of forming a circumscribed swelling on the surface of the bone, is represented by a large lobulated mass produced by the infiltration of the surrounding muscles; those most notably affected being the triceps, biceps, and those attached to the bicipital groove. The cut surface of the parts of the growth which have extended into the substance of the muscles presents a coarse fibrous network, arranged more or less conformably with the direction of the muscular fibres, and enclosing within it a very soft friable substance.

6824

*Microscopic Structure.*—The tumour is a small round-cell sarcoma.

F. W., a man aged 30, admitted into U. C. H., under Mr. Beck, Feb. 1892. Eight months previously swelling was first noticed in the outer aspect of the upper part of the left arm; for 6 weeks the swelling had been rapidly increasing. On admission the left arm and shoulder were enormously enlarged by a tumour, the circumference in the middle of the arm being  $16\frac{1}{4}$  inches (right  $10\frac{1}{2}$  inches); the forearm and hand were oedematous. On March 1 the scapula and upper limb were removed by Berger's method, some diseased glands being at the same time removed from the axilla. When the patient left the hospital on March 29 there were numerous small nodules of growth in the skin of the thoracic and abdominal walls. The wound had healed. (Mr. Beck's *Case-books*, 1892, vol. ii. p. 474.)

704. A longitudinal section of the upper part of a left femur, around the shaft and neck of which a soft sarcomatous tumour has grown. The posterior wall of the bone has been for its upper 5 cm. extensively invaded by the growth, and is for the most part indistinguishable from the contained cancellous tissue, the spaces of which are also filled with the new growth. Below this situation the femur has been transversely fractured by some slight violence; the broken surfaces are thinly covered with inflammatory exudation. The limits of the tumour are in places not definable; posteriorly it appears to have infiltrated the muscles superficial to it. The cancellous spaces and medullary canal of the whole portion of femur shown are filled with the morbid growth, which has spread further downwards within the bone than upon it. The tumour is formed by a coarse meshwork of fibrous tissue, the spaces of which contain a soft, granular, friable-looking, pale yellow substance.

2114

*Microscopic Structure.*—The tumour is a large round-cell sarcoma.

From a patient under the care of Mr. Cooper.

705. A longitudinal section of a right tibia and an oval tumour growing from its inner surface. The tumour, which measures about 9 cm. along its base of attachment and arises from the tibia near its middle, extends deeply towards the interior of the bone, the inner wall of which has for almost the whole of the distance mentioned been destroyed; behind the growth, however, a thin layer of dense osseous tissue has been formed, and except near the middle, where this is wanting, the tumour has not entered the medullary canal. The periosteum is continuous over the tumour, and at the lower part a considerable mass of new bone has been formed from beneath it. Numerous cysts, the larger of them flattened and irregular in shape, are scattered through the substance of the growth.

3362

Microscopic examination shows the greater part of the tumour to be composed of small round cells imbedded in a reticular stroma, coarser and less regular than, but somewhat resembling lymphoid tissue. Traversing this are fibrous bands containing an abundance of small spindle-cells. It may therefore, perhaps, be most properly classed as a small round-cell sarcoma.

From a man, 34 years of age, a painter by trade and in fairly good health. About seven years before admission he bruised the front of his leg, and a tumour formed soon after. There was no discoloration of the skin nor any pain unless the part was struck, but, to use the man's words, "it seemed always in the way." Eight months before his admission into the hospital the tumour began to grow rapidly, and the skin became discoloured; two days before his admission (Feb. 3, 1845) he walked some distance, which occasioned the skin over the tumour to ulcerate and the glands in the groin to enlarge. The limb was amputated at the knee-joint Feb. 10, by Mr. Liston, the patella being left in the anterior flap. The patient died on Feb. 26 from extensive abscess and irritative fever. The patella is preserved in No. 828. (Mr. Liston's *Case-books* (Males), vol. v. p. 234.)

706. Part of a hip-bone, with a mass of new growth in which it lies embedded; large portions of the tumour have been cut away. The tumour has everywhere a fine sponge-like structure like erectile tissue, the meshes of which are filled with pale yellow soft-looking substance instead of blood; in many situations the contents of the spaces are wanting, and the cut surface of the tumour has an appearance exactly resembling that of the corpus cavernosum penis. 2395

*Microscopic Structure.*—The vessels, which are very numerous, are seen to run in broad bands of delicate areolar tissue, which so intersect one another as to give an almost alveolar structure to the tumour; in the spaces between these lie multitudes of small round cells closely resembling leucocytes. Abundant hæmorrhage has occurred in many places into the spaces and amongst the cells.

707. The bones of a right forearm. The shaft of the radius for its upper 6 cm. is expanded so as nearly to fill the upper part of the interosseous space. The compact bone has disappeared from the expanded portion of the shaft, which in section presents an irregular cancellous structure, the spaces of which vary greatly in size. With the naked eye no appearance of soft growth is recognizable. The surrounding muscles are inseparably adherent to the expanded portion of the bone.

The tumour is probably a round-cell sarcoma, but on account of the condition of the specimen the microscopic examination is inconclusive. During life the swelling pulsated distinctly.

708. A right os calcis in vertical section. Growing from the outer surface of the bone and extending on to its under surface is a lobulated tumour, which extends from the anterior extremity of the bone to within 1 cm. of the tuberosity. The surface is marked by discoloured patches from hæmorrhage into the growth, and one of the peroneal tendons passes through its substance. The section shows that the growth is confined to the surface of the bone, the compact tissue of which appears to have disappeared beneath it. The cut surface of the tumour is for the most part homogeneous in appearance, but is faintly marked by white fibrous lines extending into it from the subjacent bone. 7306

*Microscopic Structure.*—The tumour is a small round-cell sarcoma.

From a man aged 26, who noticed a lump on the outer side of the right foot 11 months before his admission into U. O. H. The foot had been fixed in plaster of Paris, but the swelling increased. On admission, the swelling on the outer side of the right foot extended from a little above the external malleolus to the lower border of the foot and from the posterior border of the malleolus forwards for 3 inches. The overlying skin was red and hot; fluctuation was felt, a bruit was heard over the swelling and pulsation was felt. There was no tenderness except on standing, and the movements of the ankle were free. The nature of the tumour, which had previously been regarded as tuberculous, was determined by exploratory incision. Amputation was performed in the upper third of the leg. (Mr. Barker's *Case-Books*, 1894, vol. i. p. 218.)

709. The upper anterior part of a head. A sarcomatous tumour fills the right nasal cavity, which is widely stretched by it, and displaces the septum to the opposite side; the tumour forms an extensive swelling on the front of the face, reaching upwards on the forehead over the right orbit and as far as the inner margin of the left; the inner canthi of the eyelids are separated by a distance of about 8 cm. The right orbit is completely filled by the growth, which has displaced the eyeball before it. Over the lower, most prominent portion of the tumour the skin has, for an area about 8 cm. in diameter, been destroyed either by ulceration or sloughing. The tumour, after filling the right orbit, has come to project within the skull and forms a prominent hemispherical swelling, which occupies the whole of the anterior fossa of the base on the right side; situated close behind and below this is a much smaller, transversely elongated mass, an extension of the intraorbital growth through the sphenoidal fissure. Within the skull, the disease has spread beneath the dura mater across to the left side upon the small wings of the sphenoid bone, forming a thick layer which covers the roof of the left orbit and extends upwards upon the back of the frontal bone. The tumour, as seen behind the sawn margin of the frontal bone, where it has



been lacerated, is constructed of a delicate network of areolar tissue, which hangs in fine shreds from the surface, and supports a soft white substance occupying its areolæ. The olfactory bulbs were closely united with the intracranial portion of the growth.

5326

*Microscopic Structure.*—The tumour is a small round cell sarcoma.

The patient, a woman 24 years of age, was admitted to the hospital, under Mr. Heath, in August 1868. Seven years before this time a tumour, situated at the inner angle of the orbit, had been removed by Sir William Fergusson; a second growth took place in the cicatrix six years afterwards and was again removed by Sir William Fergusson. Within three months of the healing of the wound, however, the tumour began again to grow. Ulceration commenced about three months before her admission to University College Hospital. A violent epileptic fit occurred about a month before death, which took place in Oct. 1868.

Fuller details are contained in the Transactions of the Pathological Society, 1868-69.

710. The upper anterior part of a skull, the nasal cavity of which is completely occluded by a soft sarcomatous growth which fills its right side and has displaced the septum to the left. The growth has extended into the skull after destroying the cribriform plate of the ethmoid and part of the great wing of the sphenoid, and surrounds the optic nerve and the nerves which pass through the sphenoidal fissure. The zygomatic fossa of the right side is partly occupied by the growth; and the tumour projects also into the right orbit at the inner side, displacing the eyeball slightly outwards. The morbid growth consists of a soft white substance supported by a delicate meshwork of areolar tissue, especially evident in that portion which projects through the cribriform plate.

2665

*Microscopic Structure.*—The growth is composed of small round cells.

711. A vertical section of the upper 12 cm. of a right tibia, together with some of the surrounding soft parts of an amputation-stump. Covering the surface of the bone, except at its extreme upper part, is a layer of soft new growth which posteriorly extends into the adjacent muscles. Over the lower end of the bone the growth has a thickness of about 3 cm.

7432

*Microscopic Structure.*—The growth is composed of round cells, with a delicate stroma containing a few spindle-cells.

The patient, a man aged 33, was under the care of Mr. Godlee in U.C.H. in 1895. There was a subperiosteal sarcoma involving 5 inches of the shaft of the tibia. The patient refused to submit to amputation, and the growth, together with 8½ inches of the tibia, was excised. Within two months recurrence occurred around the lower end of the tibia, and amputation was performed in the upper third of the leg. 10½ months later there was recurrence in the stump; amputation was performed in the lower third of the thigh, and some diseased glands were removed from the groin. The primary growth contained a larger proportion of spindle-cells than the recurrence. (Surg. Reg. Report, 1895, p. 80, No. 708.)

#### OSSIFYING AND CHONDRIFYING SARCOMATA.

The specimens included in this series are sarcomata, the cellular elements of which vary, but in all of which more or less extensive ossification or chondrification has occurred. The relation between the amount of soft growth and bone or cartilage is variable; thus in some specimens the tumour is soft and the presence of bone or cartilage can only with certainty be determined by the microscope (725); in others, however, the bone or cartilage is so abundant that the growth may easily be mistaken for a simple osteoma (713) or enchondroma (726). A chondro-sarcoma differs essentially from a simple enchondroma in that the lobules of cartilage are surrounded and held together by embryonic tissue and not by a simple fibrous layer (726). The malignancy of a sarcoma of bone does not appear to be diminished by its tendency to ossification or chondrification (712, 717). Sarcomata of this group are more commonly subperiosteal (713) than central (725) in origin.

712. A left clavicle and a growth arising from it, in horizontal section. The bone is fractured at the junctions of the middle with the inner and outer thirds, and the

whole bone, with the exception of its two extremities, is surrounded by a slightly lobulated tumour. The growth is most extensive in the position of the fracture at the junction of the middle and outer thirds, where there is considerable deformity from the projection of the inner end of the outer fragment backwards. In the part of the bone invaded by the tumour the normal compact tissue is no longer recognizable, and the growth which has invaded the interior of the bone is extensively ossified. 7249

*Microscopic Structure.*—The tumour is a chondrifying and ossifying sarcoma. The stroma consists of a faintly fibrillated ground-substance containing small spindle-shaped and branched cells and abundant thin-walled capillaries. Scattered through the stroma are areas of hyaline cartilage and trabeculae of bone; in parts the cartilage is calcified.

The clavicle was removed by Mr. Heath from a man, aged 30. The primary tumour, which had been noticed for nearly a year, was removed at the Royal Free Hospital four years previously. Four months before his admission to U. C. H. the left clavicle was fractured, and on admission the broken ends were surrounded by soft solid growth, having an expansile impulse. The bone was removed through an incision along its whole length, and in disarticulating the inner end the second fracture was produced. Death occurred on the 11th day after the operation; there were secondary growths in the right frontal lobe and in both lungs. (Surg. Reg. Rep. 1888, p. 91; and 'Lancet,' 1888, vol. i. p. 721.)

713. A longitudinal section of a left clavicle and of a large ossifying tumour growing from it, together with part of the acromion process. The tumour involves the whole length of the bone, becoming narrowed and bluntly pointed at the sternal end, and composed in the rest of its extent of a lobulated mass, one of the largest lobules replacing the outer end of the bone and overhanging the shoulder-joint, the position of the head of the humerus being marked by a smooth depression on its under surface. The growth is thickest opposite the middle of its length, where its vertical measurement is 7 cm. The lobulated surface of the growth is smooth, and the surrounding soft tissues have been cleanly separated from it. No part of the clavicle is recognizable on the surface of the tumour except the articular surface of the sternal end, which is normal. From this, on the surface of the section, the unaltered outline of the bone can be traced in the substance of the tumour for a distance of 7 cm., where it becomes gradually lost in the growth. The tumour as a whole is of bony hardness, but the section shows that the texture varies somewhat in different parts. Thus the more centrally placed portions are as dense as normal compact bone, whilst in other places the structure is more open and the osseous substance appears to be incorporated with soft tissue. Especially in the inner half of its extent, where the outline of the clavicle is still recognizable, the tumour presents a distinct striation in lines radiating more or less regularly from the surface of the bone. 7004

714. The other half of the same specimen, macerated. The osseous tissue is very friable, and considerable portions of it have fallen away in the process of maceration. The arrangement of the bone in the form of delicate radiating bars and plates is well shown. 7004

*Microscopic Structure.*—The soft parts of the growth consist of spindle-cells with a slight admixture of fibrous tissue. An abundant formation of bone has occurred, especially where the fibrous tissue is most abundant.

A. W., a married woman aged 20, had complained of gnawing pain in the left shoulder for 18 months. For 12 months a tumour in the region of the left clavicle had been gradually growing; and for 3 months the skin over it had been discoloured. The patient applied at the hospital on account of an acute mammary abscess, which was opened and drained. The left clavicle was involved in a large lobulated tumour as big as a cocoa-nut. On April 13, 1893, the clavicle was removed by Mr. Godlee. The patient stood the operation well, and left the hospital on May 3. (Mr. Heath's *Case-books*, 1893, vol. ii. p. 709.)

715. A longitudinal section of the lower half of a right femur, which is, with the exception of its articular surface, enveloped by a large tumour, composed anteriorly in its deeper part of cartilage intersected by glistening lines of fibrous tissue arranged more or less vertically to the surface of the bone, and in the rest of its



extent of softer sarcomatous substance, with which the cartilaginous element is in places intimately mingled. The deepest part of the anterior portion of the tumour is ossified for a thickness of about 6 mm. Beneath this layer the compact tissue of the femur is in many parts less dense than natural, and in one situation is indistinguishable from the layer of the ossifying growth lying upon it. The medullary space, as far almost as the upper limit of the tumour, is occupied by a soft, somewhat loose-textured substance, in all respects similar to that which forms the posterior part of the tumour.

The patient, a man aged 20, was admitted in March 1876, under Mr. Heath's care. Towards the end of Oct. 1875, he noticed a small swelling, about the size of a hen's egg, over the inner condyle of the right femur, which, however, gave him no inconvenience, but continued to increase in size till his admission. He could assign no cause for the appearance of the tumour. Family history good.

Shortly after his admission to the hospital the thigh was amputated through the junction of the upper and middle thirds. The patient was discharged as cured in May. In January 1877 he was readmitted on account of recurrence of the tumour in the stump. Amputation through the hip-joint was performed on Jan. 24, cat-gut ligatures being employed, and a second ligature being placed, by means of an aneurism needle, on the femoral artery above the profunda; the case was treated on Lister's antiseptic plan. On Feb. 2 secondary hæmorrhage took place, and the patient died from exhaustion about two hours afterwards.

At the *post-mortem* examination the ligature on the common femoral was found holding quite firmly and unaltered in appearance. Below this the vessel was softened and shreddy. The other ligatures were not found. The profunda artery was closed by a firm adherent plug, and the origin of the hæmorrhage was not discoverable. Secondary tumours, firm, white, and in part calcareous, were found in the lungs, liver, and spleen. Projecting into the right auricle from its anterior wall, close to the orifice of the ascending vena cava, was a polypoid tumour, the size of a small nut; close to it, and attached between two of the muscoli pectinati, was a second growth, about as large as a pin's head. The tumour of the stump was chondro-sarcomatous, and in parts ossified.

716. A section of the lower half of the left femur of a boy. The shaft is, for its lower 12 cm., surrounded by an oval tumour which projects about 6 cm. from the popliteal surface, and is composed chiefly of closely cancellous osseous substance, through which are scattered a few small, semitransparent, whitish masses of cartilage. The wall of the shaft of the femur is in part destroyed; and the medullary cavity, from the upper limit of the tumour to the epiphysial line, is filled with dense ossifying growth. A layer of new bone has been formed upon the surface of the shaft around, and from this the periosteum is continued over the exterior of the tumour. The compact tissue beneath the growth is in many places unnaturally porous, apparently from the penetration of the tumour-substance into its vascular canals. 4135

717. A horizontal section of the right clavicle from the same case as the preceding and of a tumour, in which its outer three-fourths lie buried. The growth has extensively invaded the bone, the compact wall of which, except for about half its length posteriorly, has entirely disappeared, the medullary cavity and cancellous spaces being occupied by the growth. The tumour is composed throughout of close osseous tissue arranged in branched or small lobule-like masses. 4136

*Microscopic Structure.*—The tumour is a chondrifying and ossifying small round-cell sarcoma.

W. A., a boy, aged 17. Three and a half months before admission he felt pain in the left knee after a blow. Swelling in the region of the knee followed. Two days after admission into U. C. H. in March 1850, amputation through the thigh was performed by Mr. R. Quain. For three years the patient remained in good health and travelled about the country as a pedlar. He then wrenched the right shoulder, and the accident was followed by the rapid development of a tumour in the clavicle; this was followed by blood-spitting and evidence of consolidation in both lungs. For 6 weeks before death headache was severe, and subsequently convulsive movements occurred in the right upper limb. At the P.M. examination numerous bony tumours were found involving the right lung, and cavities containing greenish puriform fluid in the left lung. There was a large mass of growth in the mediastinum and a small soft tumour in the cortex of the left cerebral hemisphere. (See Quain's Clinical Lectures, 1884, p. 2.)

718. A longitudinal section of the upper half of a left ulna, the shaft of which is surrounded by an oval mass constructed of delicate osseous tubes arranged in a radiating manner, and formed probably in the substance of a sarcomatous tumour. The cancellous tissue of the upper end of the bone has its meshes filled with, or is replaced by, close porous osseous tissue, apparently the result of ossification of part of the tumour, which had, as in some of the preceding specimens, invaded the interior. 3173

719. The lower part of a tibia, from the inner side of which there projects a rugged deposit of new bone with pointed eminences, and composed of lamellæ arranged vertically to the subjacent surface. Superiorly the new tissue takes the form of a layer furrowed in a longitudinal direction and becoming gradually thinner till lost upon the proper surface of the shaft.

There is no history to the specimen, but it is probable that the new osseous tissue was formed in a sarcoma of the bone.

720. A sagittal section of the right arm and upper part of the forearm, together with a small piece of the scapula and a large tumour surrounding the upper three-fourths of the humerus. The tumour measures at its upper part 17 cm. from before backwards; both in front and behind it rises to the level of the top of the humerus. Anteriorly the growth extends downwards as far as the middle of the shaft of the humerus, whilst posteriorly it reaches to the junction of the third and lowest fourths. In its lower three-fourths the shaft and the periosteum covering it are unaltered, but in the upper fourth, from which the tumour appears to have originated, the surface of the bone is irregular, and in parts intimately connected with the growth. In this situation the bone is transversely fractured. The head of the bone is itself unaffected, but posteriorly the growth extends into the cancellous tissue as high as the epiphysial line. Throughout its whole extent the tumour has undergone ossification, the cut surface being intersected with opaque white fibrous bands, and presenting in some parts small homogeneous areas having the appearance of cartilage. In the lower part of the posterior portion of the tumour is an area 6 cm. across, with a coarse radiating structure resulting from the arrangement of the lines of ossification. The deltoid and other muscles of the shoulder are closely incorporated with the outer aspect of the upper part of the tumour, which is divided by shallow grooves into several large lobes.

*Microscopic Structure.*—The tumour is a chondrifying and ossifying sarcoma. The greater part of the stroma is composed of fibrillated tissue, rich in small spindle-cells; elsewhere small round cells lie in a delicately reticular stroma.

J. D., aged 16, was admitted, under the care of Mr. Heath, July 2, 1883. Swelling of the right arm had been noticed for 2 years, but during the last 6 months had increased much more rapidly. Operation July 4: large flaps were turned backwards and forwards from the tumour by incisions meeting above on the top of the shoulder, and below in the axilla. The limb was in the first instance removed by sawing through the neck of the scapula; but, as the growth was found to involve the subscapularis and infraspinatus muscles, the whole scapula was removed, after sawing through the outer part of the clavicle. The axillary artery was seized with Spencer Wells's forceps as divided, and ligatured. The patient left the hospital Aug. 30. Local recurrences were removed in March 1884, May 1885, January 1887, and November 1888. Early in 1890 there was recurrence below the clavicle, too extensive for operation, but the general health was good. (See Mr. Heath's *Case-books*, 1883, vol. i. p. 68, and Surg. Reg. Report, 1890, p. 178, No. 279.)

721. The outer half of the lower part of a left femur, and of an ossifying sarcoma growing from it. The tumour occupies the posterior and outer aspects of the bone, extending downwards posteriorly so as slightly to overlap the margin of the articular cartilage, and having a vertical measurement of 10 cm. The outer surface, from which the soft parts have been cleanly removed by dissection, is smooth and lobulated, and the borders of the tumour overhang to a varying degree the surrounding surface of the shaft, upon which a thin layer of new bone has been deposited. On the cut surface of the specimen the posterior compact wall of the femur is readily traceable beneath the tumour, except at one spot. In the



greater part of its extent the cut surface of the tumour is composed of compact or closely cancellous bone. In certain parts, however, it is composed of soft tumour-substance, which is seen chiefly in three separate areas; one of these is the section of a small superficial lobule; another is deeply embedded in the upper part of the tumour, whilst the third is situated in the deepest part of the growth, in the position in which the compact wall has been destroyed. At this spot the tumour is directly continuous with a deposit of soft or slightly ossified growth which occupies the medullary canal for a distance of 6 cm., and is readily distinguishable from the normal medulla above and the cancellous tissue of the lower extremity below.

Before maceration the inner half of the specimen presented an almost exactly similar appearance, except that it contained a much larger lobule in which no ossification had occurred.

7566

*Microscopic Structure.*—A section of the unossified part of the growth shows it to consist of small rounded cells. The intercellular substance is in parts fibrillated, and in parts consists of an abundant hyaline substance. A few multinucleated cells are present.

**722.** The inner half of the same specimen, macerated.

7566

From a woman, aged 26. Amputation was performed by Mr. Barker on May 6, 1896. Death occurred on Nov. 21, 1896, and was said to have resulted from "acute tuberculosis."

**723.** The anterior half of the upper two-thirds of a left humerus, and of an ossifying sarcoma growing from it. The upper half of the bone, with the exception of the articular surface, is surrounded by the tumour, the surface of which is lobulated and intimately incorporated with the surrounding muscles. On the cut surface of the specimen the compact tissue of the bone can be traced beneath the tumour, except in the position of the great tuberosity, where the growth has invaded the cancellous tissue of the head and has undergone extensive ossification in its substance. Ossification has also occurred in the whole of the upper part of the growth; the lower unossified parts are firm in texture, and present a faint radiating striation.

At the upper part of the specimen is preserved a section of one of the axillary glands, which is the seat of an ossifying growth.

7188

*Microscopic Structure.*—A section of the unossified part of the growth shows it to consist of masses of small rounded cells lying in a fibrillated stroma, and held together by bands of dense fibrous tissue.

**724.** The posterior half of the same specimen, macerated.

7188

G. C., a man aged 24, was admitted into U. C. H., under the care of Mr. Barker, on Nov. 28, 1893. Since March he had suffered from pain and weakness in the left arm, and for 3 months there had been increasing swelling about the shoulders and the upper part of the arm. On admission a large hard tumour involved the upper part of the humerus, and the shoulder-joint was fixed. Amputation at the shoulder-joint was performed on Nov. 30, and on Dec. 28 a mass of diseased glands was removed from the axilla. When the patient left the hospital, on Jan. 17, there were already signs of secondary deposits in the lungs, and death took place soon afterwards. (Mr. Barker's *Case-books*, 1894, vol. iii. p. 209.)

**725.** The inner half of the upper part of a right tibia, which is the seat of a cartilaginous tumour. The growth is situated in the anterior part of the bone, involving the anterior extremity of the epiphysial line, and projecting slightly beneath the periosteum in the region of the tubercle. The growth has a vertical extent of 3.5 cm., and at its deepest part it reaches the middle of the bone. Its limits are very accurately defined, and the cancellous tissue around it, for the distance of nearly 2 cm., is denser than natural. The enlargement of the anterior aspect of the tibia results not only from the projection of the growth, but also from thickening of the compact tissue below it. The cut surface of the growth presents a mottling of grey and yellow areas, and at its deepest part the growth

is cystic. Continuous with the lower border of the tumour is a small lobule growing into the surrounding bone. 6460

*Microscopic Structure.*—The growth consists of a mixture of sarcomatous tissue, myxomatous tissue, and cartilage, which pass by imperceptible gradations one into another. The cell elements in the sarcomatous areas are small and irregularly rounded in outline.

From a boy, aged 16 years. Amputation was performed by Mr. Cowell at the Westminster Hospital.

726. A longitudinal section of the upper half of a right tibia, with the lower end of the femur, and a large tumour which has grown from the posterior surface of the former so as almost to surround it for about its upper 11 cm. The surface of the tumour is deeply lobed, the great vessels and nerves lying in deep furrows on it or embedded in its substance. The tumour has grown so as to occupy and project through the upper part of the interosseous space. In structure it appears constituted exclusively of milky white or semitransparent cartilage arranged in small closely-packed masses, between which fine fibrous partitions pass; the injection shows the latter to conduct vessels, in some places of considerable size, around and between the masses mentioned. Posteriorly the line of the tibia is for the most part unaltered, and appears to be simply overlapped by the tumour, the periosteum remaining upon it; but about the middle it is slightly uneven, and its defects are occupied by the morbid growth. 2387

*Microscopic Structure.*—The greater part of the tumour consists of cartilage, the hyaline matrix of which is small in amount. Between the lobules of cartilage is a richly cellular substance, the cell-elements of which are mostly spindle-shaped and very irregularly arranged. The line of demarcation between the cartilage and the cellular tissue is ill-defined. The matrix of the cartilage is calcified in patches.

727. Part of a frontal bone, with the cribriform plate of the ethmoid and adjoining part of the sphenoid, and three irregular lobulated masses of a recurrent enchondromatous tumour, before the growth of which the central part of the frontal and the lateral masses and vertical plate of the ethmoid have disappeared, so as to form an irregular cavity within which the parts of the tumour lay; the growth appears to have filled the frontal sinus. The mass suspended from the left orbit protruded into the mouth. The weight of the entire tumour was nine ounces. 5319

*Microscopic Structure.*—The tumour is a chondro-sarcoma. The condition of the specimen obscures the details of the structure.

The patient, a man 34 years of age, was admitted into the hospital under Mr. Heath's care in January, 1868, with a large tumour of the right side of the face. When seventeen years old he noticed a pimple on the right side of the nose, which increased rapidly, and when excised by Mr. Le Gros Clark, in 1851, was as large as a walnut. The tumour recurred and was again removed the following year. After this the patient remained in good health till 1857. During this year, while in America, the tumour again appeared, and Professor Gunn found it necessary to remove the entire right upper jaw and along with it the greater part of the tumour. A small portion of the tumour at the inner side of the orbit was, however, left. This soon increased rapidly, but the patient refused to allow an operation, and in 1865 returned to England. At the time of his admission to the hospital (1868) the right side of the face was greatly disfigured by a large tumour, by which the eye was thrust aside, but without loss of vision. The tumour appeared externally to consist of two parts, separated by a horizontal sulcus, at the bottom of which a fistulous opening, the result of the second operation, was still visible. The upper and more prominent portion had invaded the orbit, reaching to its upper border and extending beyond the middle line of the nose; the lower portion of the tumour involved the ala of the nose and adjacent part of the cheek, both of which were much distended. Both nostrils were completely blocked, and had been so for months. The patient died six weeks after the removal of the parts of the tumour shown in the preparation. For further particulars see the 'Transactions of the Pathological Society,' vol. xix. p. 328.

728. A right femur, the lower half of the shaft of which is completely invested by a tumour. The bone has been fractured, probably by some slight violence, near the junction of its middle and lower thirds. The lower fragment, with which the growth is most intimately connected, has been displaced upwards upon the inner



side of the upper and rotated to such an extent that its patellar surface looks directly outwards; the end of the upper fragment, slightly rounded, lies embedded in the anterior part of the tumour. The portion of the tumour lying to the inner side of the upper fragment, and reaching for about 7 cm. above its lower end, has been extensively lacerated, apparently owing to the displacement following the fracture. The wall of the upper fragment is uneven or lowly undulating, from partial absorption resulting from the pressure of the growth, which, however, does not appear to have invaded it. The interior of the lower fragment, as far as the epiphyseal junction, is occupied by the new growth, which for a considerable extent anteriorly is directly continuous with that upon the exterior, the compact wall of the bone having been in parts wholly destroyed. This intra-medullary portion of the tumour has, for the most part, undergone ossification. The growth extends also for about 6 mm. within the medullary cavity of the upper fragment. Ossification has likewise occurred in portions of the tumour without, chiefly in the portion which lies immediately below the overhanging end of the higher fragment of the bone. The tumour is constructed of a soft-looking, friable, white substance, pervaded and supported by a delicate reticulum of connective tissue; in places it is marked with patches of opaque ochre-yellow, probably parts which have undergone degeneration and where hæmorrhage has occurred. The femoral vein, in the situation marked between two bristles, contains a small, oval, pedunculated mass of substance similar to that composing the main tumour. 4183

*Microscopic Structure.*—The growth is an ossifying sarcoma. The cell-elements are spindle-shaped, but the condition of the specimen renders satisfactory examination impossible.

J. V., aged 55, a farmer, had suffered from dull aching pain in the lower part of the right thigh for 2 years; there was no recognisable swelling of the femur, but slight œdema of the leg. About a year after the onset of the pain the patient was knocked down by a sheep and the right femur fractured below the middle of the shaft. The fracture was treated with a long splint, and in two months the patient could walk with crutches; there was considerable thickening at the seat of the fracture. Three months later he was thrown from a pony-chaise, after which the enlargement of the thigh gradually became much more marked. On admission into U. C. H. under Mr. R. Quain, two years after onset of the pain, the whole limb was much enlarged and the cutaneous veins dilated. The tumour of the femur was most prominent on the inner side of the lower part of the thigh, where the skin was reddened and the tumour projected through an opening an inch in diameter. Death occurred 6 weeks after admission. Secondary deposits, extensively ossified, were found in the omentum, diaphragm, and lungs. (*See Quain's Clinical Lectures, 1884, p. 9.*)

729. Two portions of a right scapula which was removed by two operations for a sarcomatous tumour. The lower specimen, which consists of part of the first portion removed, includes a strip of the body of the scapula. Attached to its dorsal surface and slightly overlapping the axillary border is a rounded tumour measuring about 3 cm. in diameter. The surface of the growth is intimately connected with the teres major muscle, the fibres of which can be traced over the capsule of the tumour. The section of the tumour shows it to consist of areas of semitranslucent material intersected with fibrous bands and partly separated by irregular spaces probably resulting from softening.

The upper specimen consists of the upper half of the scapula, which was removed at a later operation. One irregular mass of growth involves the anterior part of the neck and the under surface of the coracoid process. The tumour extends into the substance of the subscapularis muscle. A second mass of growth occupies the great scapular notch. Both portions present naked-eye appearances similar to those presented by the other specimen, but are more extensively softened. The line of section of the body is smoothly healed, and the surface of the glenoid fossa is covered with dense fibrous tissue and adherent muscular fibres. 7782, 7534

*Microscopic Structure.*—The tumour is composed in the greater part of myxomatous tissue, irregularly mixed with which are areas composed almost entirely of round and oval cells, and also areas of cartilage. The axillary artery, at the point where it was adherent to the growth, was filled with myxomatous tissue.

A. B., a woman, aged 44, was admitted into U. C. H. under the care of Mr. Godlee on Oct. 28, 1895. Since the beginning of the year she had experienced almost constant pain in the right shoulder and arm. On admission a tumour could be felt, fixed to the dorsal surface of the scapula in its lower part. The tumour was removed, together with the lower part of the scapula and nearly the whole of the *teres major* muscle. In May 1896 a recurrent growth in the posterior part of the axilla, involving the *latissimus dorsi*, was removed. In Oct. 1896 amputation at the shoulder-joint was performed for a recurrent growth. In March 1897 a mass of growth could be felt in the position of the coracoid process and below the acromion. The remaining half of the scapula was removed. Death occurred in May 1897, with cerebral symptoms. (Mr. Godlee's *Case-books*, 1897, vol. i. p. 68.)

### MYELOID SARCOMATA.

These are almost, if not quite, peculiar to bone. They are composed of round cells and spindle-shaped cells, amongst which are scattered large masses of protoplasm of irregular shape containing many oval nuclei. They are extremely vascular and occasionally pulsate (737). They occur most frequently about the articular ends of bones, usually commencing in the cancellous tissue, and expanding the compact bone over them (730, 732). When growing in the articular extremity they often stretch the cartilage over them, but very rarely penetrate into the articular cavity (732).

A myeloid sarcoma is very soft; its growing margin is pink, and its centre yellow from fatty degeneration; scattered through it are purple and maroon-coloured patches, resulting from hæmorrhage (735). The tumour frequently contains cysts of considerable size (732, 736). In some instances the tumour is represented merely by a hollow in the bone filled with blood and lined with a very thin layer of soft tumour-substance. This is the so-called *blood-cyst* of bone (733). Myeloid sarcomata are common in the jaws (*see* Diseases of the Jaws). These tumours if completely removed, scarcely ever recur either locally or internally, and indeed by some pathologists they are regarded as non-malignant.

**730.** The lower half of a left femur, the shaft of which has been expanded and in part destroyed, a short distance above its lower end, by the growth of a myeloid sarcoma within it. On the outer side the tumour is still confined within the femur, which presents a marked oval swelling extending over a distance of about 5 cm.; on the inner aspect it is uncovered by the wall of the bone, at first expanded over it, and here the tumour forms a smooth ovoidal mass, measuring about 9 cm. in length, and projecting about 3.5 cm. above the surrounding surface. As displayed by the section, the growth is formed throughout by a homogeneous, friable substance, through which are scattered numerous minute circular apertures, some of them the openings of cysts, but most of them probably the mouths of vessels. In parts the tumour presents a brownish discoloration, resulting from hæmorrhage into its substance. The soft mass of the tumour is confined within a thick fibrous investment, formed principally by the hypertrophied periosteum continued over it.

3749

*Microscopic Structure.*—The large multinucleated cells are few in number, but a considerable number of cells contain two or three nuclei.

**731.** The anterior half of the lower extremity of a right femur, expanded by the growth of a tumour within it. The transverse measurement of the tumour is 10 cm., and its vertical measurement 8 cm. It reaches downwards to the articular cartilage, and upwards on the inner side close to the level at which the bone has been sawn. The tumour, in the greater part of its extent, is contained within a shell of expanded bone, but in some parts the bone is wanting and its place taken by a thick fibrous layer.

The section shows that the tumour has been extensively broken down, probably as the result of hæmorrhage into its substance, and that at its upper part it has



extended a short distance between the periosteum and the surface of the shaft upon its inner aspect.

7950

*Microscopic Structure.*—The tumour is a giant-cell sarcoma. The other cell-elements are mostly small and spindle-shaped.

J. H., a man, aged 28, was admitted into U. C. H. under the care of Mr. Barker, Jan. 11, 1898, on account of swelling of the right knee caused by an enlargement of the lower end of the femur. In Nov. 1896 the limb had been bruised by a blow with the handle of a crane. In March 1897 the knee was so painful that the patient could not stand; the joint was treated at St. Bartholomew's Hospital with Scott's dressing and much relieved; a short time later the patient slipped and wrenched the knee; this was followed by increased swelling, but he continued to get about with the aid of a stick. On Jan. 13, 1898, the presence of a tumour in the lower end of the femur having been ascertained by exploratory incision, the extremity of the bone was removed and the end of the shaft driven into a trephine-hole in the head of the tibia. On Jan. 27 amputation was performed at the junction of the middle and lower thirds of the thigh, and, as the medulla of the femur at this level was found to be occupied by growth, another 5 cm. of the bone were removed. Discharged on March 1. (Mr. Barker's *Case-books*, 1898, vol. ii. p. 236.)

732. The inner half of the upper extremity of a left tibia which is the seat of a large myeloid sarcoma. The tumour, which expands the upper extremity of the bone and has a more or less globular shape, measures antero-posteriorly 14 cm. and vertically 12 cm. The compact tissue of the expanded portion of the bone is represented merely by scattered plates on the surface of the tumour, which is in other parts invested only by a dense fibrous layer continuous with the periosteum, and with which, on the upper and anterior part of the tumour, the ligamentum patellæ is connected. Below the tumour a small portion of the normal shaft of the tibia is seen; the anterior wall of this ends abruptly, but the posterior wall can be traced backwards for a distance of 4 cm. on the surface of the tumour. On its upper aspect the specimen presents the inner of two deep hollows in which the condyles of the femur rested on the surface of the tumour. The floor of this hollow is still covered with the remains of the articular cartilage. On section the tumour is extensively cystic; the solid portions have a finely granular texture and a yellow or brownish-red colour. Three large cysts are seen, the largest of which measures 8 cm. by 7 cm. Each cyst is surrounded by a well-marked wall of condensed tissue, and appears, from the presence of imperfect septa, to have arisen from the coalescence of smaller spaces. In their present condition the cysts are partially occupied by granular and gelatinous material.

6684

*Microscopic Structure.*—The giant-cells are very irregularly distributed, being absent from many parts of the section. The other cell-elements vary in shape, but spindle-cells predominate; the stroma is fibrillated.

From a woman aged 42, under the care of Mr. Godlee in U. C. H. in 1890. The swelling in the region of the knee, which had been increasing for three years, had been treated for rheumatism, with fomentations, Turkish baths, and galvanism. Amputation was performed above the condyles of the femur. In the recent state the growth was soft and of a dark red colour, and the cysts contained clear or blood-stained fluid.

733. The upper half of a right tibia, which has been obliquely divided by a vertical section through the internal tuberosity. Occupying the posterior part of the upper extremity is a cavity, the vertical measurement of which is 6 cm. The deepest part of the cavity reaches to the middle of the bone, and its upper limit lies immediately below the articular cartilage covering the posterior part of the outer tuberosity. In its deeper part the cavity is surrounded by the cancellous bone, which presents to the naked eye a perfectly normal appearance. Posteriorly, however, the compact wall has been destroyed to an extent equal to that of the cavity, which is closed by a thick membrane continuous with the periosteum covering the surface of the bone around the cavity. At the lower limit of the cavity this membrane rises from the surface of the bone 1 cm. below the level to which the compact tissue has been destroyed. The whole inner surface of the cavity is lined by a very thin layer of soft tissue, which is almost uniformly stained of a brownish colour by altered blood. That part of the surface which is formed by the bone presents small pits and depressions.

7265

*Microscopic Structure.*—The layer of soft tissue which lined the cyst presented the characteristic structure of a giant-cell sarcoma.

The patient was a youth aged 19, under the care of Mr. Godlee. The first symptom was pain at the back of the right knee; this was noticed in May 1894 whilst driving, and was thought to result from a strain. The chief symptom that developed later was inability to flex the knee beyond a right angle. The tumour was not easily felt, as it projected at the back of the bone. Operation Oct. 1894:—An incision into the tumour showed it to be a blood-cyst lined with a small quantity of reddish soft growth, which was in part removed with a sharp spoon. Amputation was performed through the condyles of the femur. The patient was in good health and free from any sign of recurrence 5 years after the operation.

The other half of the specimen is in the Museum of the R. Coll. of Surgeons.

734. The left index and middle fingers, with the greater part of their metacarpal bones, and a tumour which has grown from the metacarpal bone of the index finger, the parts shown having been removed by operation. The tumour has grown within the metacarpal bone, the lower part of the shaft of which has been expanded over it; on the dorsal aspect it has protruded through the skin, and forms a deeply lobed or cauliflower-like mass, in places covered with a thin layer of sloughing tissue.

5414

*Microscopic Structure.*—The tumour is a typical myeloid sarcoma, containing large numbers of giant-cells with multiple nuclei spread throughout the other elements composing it.

From a woman, 22 years of age, who struck the knuckle five months before she applied to the hospital. A swelling appeared, was cut into, and a fungous protrusion followed, which rapidly increased in size. (Sir J. Erichsen's *Case-books*, vol. i. 1870-72, p. 89.)

735. A tumour involving the upper extremity of a humerus, in vertical section. By the growth of the tumour the bone is converted into an irregular globular mass 9 cm. in diameter.

At the lower limit of the specimen is the divided and unexpanded shaft of the humerus; from this the expanded compact tissue forms a continuous layer over the inner aspect of the tumour as far as the margin of the articular cartilage; externally, however, the expanded compact tissue stops abruptly at a distance of 2.5 cm. from the line of section, beyond which limit the slightly lobulated outer surface of the tumour is invested with a fibrous layer, with which the surrounding muscular attachments are continuous. At the upper and inner aspect of the tumour the articular cartilage of the head still remains, but the normal shape of the articular surface is entirely lost, as the result of extension of the growth beneath and around it. The cut surface of the tumour presents marked variations in colour; in the greater part of its extent it has a deep maroon tint, intersected with streaks and patches of a paler yellow colour; above the centre of the section a large patch, more than 2.5 cm. across, has an almost uniform yellowish-white colour.

7794

*Microscopic Structure.*—The tumour is a myeloid sarcoma. The large multinucleated cells are very abundant, the other elements being small and rounded or irregularly oval in shape.

From a young woman under the care of Mr. Bilton Pollard. It had been proposed to excise the upper end of the humerus, but an exploratory incision showed the surrounding muscles, especially the deltoid, to be so intimately connected with the growth that amputation was performed through the shoulder-joint.

736. A sagittal section of the lower part of the left femur and the tibia together with the fibula, the contiguous parts of the tibia and femur being invaded by a tumour. The upper extremity of the tibia is greatly expanded by the growth of a myeloid sarcoma within it. A thick layer of the expanded bone is still present over the greater part of the surface of the tumour, but in front, below the level of the tubercle of the tibia, the growth has perforated the bony shell and protrudes through an opening in the integuments in the form of a slightly lobulated mass having a vertical measurement of 5.5 cm. No trace remains of the articular surfaces of the tibia and femur, and the growth extends continuously from one bone to the other, obliterating the knee-joint and extending into the substance of the lower extremity of the femur to within 1 cm. of the epiphysal line. As a result of the extensive destruction of the bones, the remains of the



lower end of the femur have sunk down into the substance of the tumour to such an extent that the posterior end of its epiphysial line is on a level with the summit of the head of the fibula, whilst the expanded outer tuberosity of the tibia forms a prominent rounded border overlapping the outer condyle of the femur as high as the upper border of the patellar surface. The tumour is soft and friable, and contains cysts in its substance, the two largest of which are lined with a smooth membrane.

*Microscopic Structure.*—The multinucleated giant-cells are only present in small numbers; from considerable areas of the section they are altogether absent, the cells being round, oval, and spindle-shaped.

B. H., a girl aged 17, admitted into the Cancer Hospital under Mr. Stonham in 1885. She had been treated previously at St. Bartholomew's Hospital, where the tumour in the head of the tibia was removed by scraping, as amputation was refused. Suppuration followed, and the invasion of the femur by the tumour probably resulted from disorganization of the knee-joint.

737. The upper half of a left tibia, the extremity of which has been hollowed out and expanded by the growth of a tumour within it. In its present condition the cavity, which measures 10 cm. from above downwards, is widely open, as the result of the removal of its inner wall; in the rest of its extent it is almost everywhere surrounded by a thick shell of the expanded bone, and at its upper part is closed merely by the articular cartilage. The tumour-substance which lined the cavity has been cleanly removed and is in part preserved in the upper part of the specimen.

8034

*Microscopic Structure.*—The cell-elements are round and oval, and mixed with these in some parts are large numbers of multinucleated cells. The growth is very vascular, and is the seat of recent extravasation and abundant yellowish blood-pigment.

J. W., a man, aged 33, was admitted into U. O. H. under the care of Mr. Godlee on April 30, 1898. He had been suffering pain in the left knee for 9 months, and the part had been swollen for 6 months. On admission there was considerable enlargement of the upper extremity of the tibia, a small area on the inner tuberosity being soft, tender, and pulsating slightly; there was an elastic swelling above the patella beneath the quadriceps. On May 10 an incision was made over the soft area, and a reddish-brown growth exposed; on cutting into this a large cavity in the bone, lined with similar growth, was exposed; this was cleanly removed by scraping; the swelling above the patella contained blood. On May 13 amputation was performed through the lower third of the femur. (Mr. Godlee's *Case-books*, 1898, vol. ii. p. 190.)

#### SECONDARY MALIGNANT TUMOURS OF BONE.

Sarcoma, although so commonly met with as a primary growth in the bones, may also occur as a secondary deposit. Carcinoma, on the other hand, cannot occur primarily in osseous tissue.

Deposits of sarcoma or carcinoma, in many instances multiple, may form in the bones secondarily to a primary tumour in some other part of the body. All the different varieties of sarcoma may be met with in the form of secondary deposits, melanotic sarcoma being indeed necessarily secondary (741, 742).

Secondary deposits of carcinoma are very common in the bones, but in the large majority of cases such deposits are of the spheroidal-cell variety (743 to 749). Columnar-cell carcinoma (750) and squamous-cell carcinoma (752, 753) much less commonly lead to infection of the bones. Secondary deposits of carcinoma are always central in origin (743), and in the case of the long bones may cause spontaneous fracture even when the tumour is still of small size and not recognisable clinically (744).

Not only may true secondary deposits of carcinoma occur in the bones, but the osseous tissue may be invaded directly by a primary growth originating in its immediate vicinity. Thus, for example, a squamous carcinoma of the skin of the leg may grow into and even occasion spontaneous fracture of the tibia; and a rodent ulcer of the face may gradually completely perforate the subjacent bone (764). The

carcinomatous tumours which so frequently involve the jaws originate, not in the bone itself, but in the mucous membrane covering it or in epithelial structures contained within it (*see Diseases of the Jaws*).

738. The right orbital plate and adjacent part of a frontal bone. Projecting into the roof of the orbit is an oval tumour, the anterior border of which corresponds to the upper margin of the orbit. On the upper aspect of the orbital plate the tumour forms a slight elevation, the bone being eroded and the surface of the swelling rough. 5454

*Microscopic Structure.*—The tumour is a small round-cell sarcoma. The patient died with multiple sarcomatous growths. The situation of the primary tumour is unknown.

739. A right scapula, the upper part of which is the seat of a large lobulated sarcomatous growth. The tumour is divisible into two main portions, separated by a shallow groove in which lies the spine of the scapula. The lower smaller portion occupies the upper and outer part of the infraspinous fossa and overhangs the posterior and upper aspects of the shoulder-joint. The upper and larger portion of the tumour fills the supraspinous fossa, and at its upper part forms a globular mass overhanging the coracoid process, covering the acromion, and marked by a deep hollow in which lay the outer end of the clavicle. 6814

740. The free end of one of the lowest ribs, the extremity of which, together with its cartilage, is embedded in an irregularly lobulated oval tumour, measuring 6 cm. in its longer diameter. From the relations of the tumour to the rib it would appear that the former had grown from the periosteum. 6814

This and the preceding tumour were secondary to a primary growth in the breast.

741. A longitudinal section of the ungual and adjoining part of the first phalanx of a thumb, together with the adjacent soft parts, and a melanotic sarcomatous tumour which has grown from them. The tumour is of very irregular form, somewhat hemispherical, but flattened in shape, and about 3.5 cm. in diameter; it projects from the dorsal aspect in the situation of the matrix of the nail, in the deeper part of which the tumour appears to have first grown. Posteriorly it overhangs the surrounding soft parts, and in this situation there remains upon its under surface a portion of the nail, which is bent completely backwards and is overlain by the growth. The tumour has spread, also, by a nodulated extension into the tough adipose tissue on the palmar aspect of the phalanx, and has infiltrated the anterior half of the ungual phalanx, the precise extent of its invasion being beautifully marked by the coloration of the growth; the outline of the bone, in the plane of section, is everywhere traceable, but its cancellous spaces are filled with blackened sarcomatous tissue.

The tumour is firm, almost homogeneous in structure, and variously coloured from iron-grey to deepest sepia.

*Microscopic Structure.*—The cell-elements are large, round and oval, and coloured in the greater proportion with pigment-granules.

From a man, 53 years of age, admitted under Mr. Heath's care, February 1877. Two years previously he struck his thumb with a hammer. The nail separated and the end of the thumb festered, and the parts did not completely heal. About a year afterwards he ran, by accident, the brass fastening of his necktie into the thumb for about half an inch. The thumb bled for a few days, and the growth commenced to form in about a week. By July (four months after the second injury) the tumour had grown to the size of a nutmeg, and it bled very easily. The growth was at that time cut away and the parts cauterized, the remains of the nail being extracted. The tumour reappeared, and about three months before admission a swelling formed in the axilla.

No family history of tumours. At the date of admission the swelling in the left axilla was about the size of a duck's egg, movable, and very elastic. Scattered all over the body there were small rose-red maculae. In the right thigh was a flat, oval tumour, soft and adherent to the skin; and a similar but smaller growth existed on the left forearm, the superjacent skin, however, being movable over it.

The tumour of the thumb was removed by amputation through the first phalanx. Mr. Heath made an incision over the tumour in the axilla, which was found to be distinctly



encapsuled by fibrous tissue; on attempting to tear it out the wall burst, and the soft contents of the tumour escaped; the cyst-wall was then detached, and the wound washed with solution of chloride of zinc. The patient was discharged a month after the operation, the thumb having quite healed; a sinus three inches long remained in the axilla, but was in process of closing.

- 742.** The upper part of a left tibia and fibula, together with a piece of the skin of the front of the leg. The tibia, which is the seat of a deposit of melanotic sarcomatous growth, has been divided antero-posteriorly. In the skin is an oval ulcer, measuring 6 cm. by 5 cm., the floor of which is formed in its greater part by a lobulated growth; the superficial part of the largest lobule has been removed to expose the brownish-black colour of the tumour-substance. On the outer aspect of the tibia, a considerable lobulated mass of the growth projects into the interosseous space. The section of the bone displays the presence of an extensive deposit of almost black growth in its interior. The deposits, which are very sharply defined from the healthy cancellous bone around them, take the form of rounded masses extending from within about 1 cm. of the articular cartilage downwards for 8 cm. The anterior layer of compact bone has been completely destroyed in the region of the disease, so that the growth in the floor of the ulcer is directly continuous with that in the bone. Posteriorly, in the plane of the section, the compact tissue is in two separate places being invaded by the growth. The deposits in the bone are quite soft, except the highest of them, in which the trabeculae of the cancellous issue are still traceable. 6276

"The patient, a woman, aged 39, had had a primary growth removed some years previously from the right suprascapular region; this was of small size. The growth in the tibia was first noticed in Nov. 1886; in Jan. 1887 it was scraped away, but reappearing, Mr. Heath successfully amputated through the condyles in March 1887. On leaving the hospital the patient had numerous recurrent growths in the skin." (*See Trans. Path. Soc. 1888, vol. xxxix. p. 277.*)

- 743.** The fibula and outer half of the tibia of the left side. The tibia is the seat of two separate deposits of secondary spheroidal-cell carcinoma. The upper and larger deposit, which completely infiltrates the upper extremity, extends downwards for a distance of 12 cm. The growth, which has evidently commenced in the interior of the bone, has led to extensive destruction of the compact wall and resulting enlargement, the greatest antero-posterior measurement being 7 cm. At a lower level in the bone, and separated from the upper growth by a distance of 4 cm., is a second deposit involving the medulla and the anterior compact wall for a distance of 9 cm. In its upper part this growth has extended through the compact bone and forms a swelling on the outer surface. The head of the fibula is enlarged, and appears to be directly invaded by the growth in the upper extremity of the tibia. 7381

From a woman who died some time after removal of the breast for a primary spheroidal-cell carcinoma. There were also deposits in other parts of the body. The femur from the same case is preserved in No. 55.

- 744.** A vertical section of part of the middle of the shaft of a femur. As the result of a central deposit of spheroidal-cell carcinoma in the bone, spontaneous fracture has occurred, the fragments, which overlap to the extent of 5 cm., being firmly held together by fibrous tissue. The medullary cavity of each fragment is filled with soft growth for a distance of 3.5 cm. from the line of the fracture. The end of each fragment is closed by a thick layer of fibrous tissue covering the surface of the central growth. 5577

- 745.** The posterior half of the upper part of a left tibia, from the same case as the preceding specimen. The upper end of the shaft, for a distance of 5 cm., is occupied by a soft deposit of carcinoma, which expands the bone. Two smooth-walled cysts are divided on the cut surface of the tumour. 5576

This and the preceding specimen were obtained from a woman, aged 45, whose left breast had been removed for carcinoma 30 months previously. She was admitted into U. C. H., under

Mr. Marshall, on account of a spontaneous fracture below the middle of the left thigh. There had been pain in the limb for 10 months, and the fracture had occurred 9 days before admission, whilst the patient was getting out of bed. Splints were applied, but no union having occurred at the end of 2 months amputation was performed through the hip-joint. Bed-sores formed, and the patient died of exhaustion on the 46th day. There were many secondary deposits in the pleuræ and peritoneum. (*See Surgical Registrar's Report, 1881, pp. 51, 104, 132, No. 748.*)

- 746.** The upper extremity and adjoining part of the shaft of a left femur. The section shows that the substance of the trochanters and of the neck and head is infiltrated with new growth, as the result of which a fracture has occurred through the upper part of the shaft, below the level of the small trochanter. The fracture has become consolidated after great displacement. The fractured surface of the upper fragment is tilted almost directly forwards, and the head and great trochanter are so much depressed that the axis of the head and neck forms an angle of  $45^{\circ}$  with that of the shaft. 5619

The primary growth was in the breast.

- 747.** Two vertical slices of a sternum in which are numerous secondary deposits of carcinoma. The contour of the bone is unaltered. The deposits are small and irregularly distributed through the cancellous tissue; the bone around each is congested. 8295

From a woman aged 54, who was admitted into U. C. H. with an ulcerating carcinoma of the left breast and pleurisy on the same side. There were secondary deposits in the mediastinum, lungs and pleuræ, liver, spleen, and left kidney. (*Mr. Barker's Case-books, 1897, vol. ii. p. 114.*)

- 748.** A right humerus, the upper extremity of which is the seat of a secondary deposit of carcinoma. The upper limit of the growth corresponds almost exactly with the margin of the articular cartilage; it projects most prominently on the anterior and inner aspect of the bone, in which situation the insertions of the latissimus dorsi and teres major muscles are incorporated with the lower border of the tumour. The shaft is fractured in a slightly oblique direction at the lowest limit of the tumour. A section made into the growth shows that it completely infiltrates the upper extremity of the bone, no trace of the compact tissue being recognisable. The cut surface of the growth presents a slightly fibrous and in parts reticular structure. 6390

*Microscopic Structure.*—The tumour consists of a fibrous stroma with spindle and round cells enclosing small spaces; these spaces are lined in parts with a single layer of cubical cells containing large oval nuclei; in other parts the alveoli are completely filled with spheroidal cells.

From a woman aged 52, admitted into U. C. H., under the care of Mr. Godlee, in Sept. 1888. For 12 months she had complained of a feeling of numbness in the right arm; for 9 months the limb had been painful; for 5 months there was loss of power in the limb and for 2 months swelling about the shoulder. On admission there was swelling about the anterior and outer aspects of the right shoulder as low as the insertion of the deltoid. The skin was slightly reddened and the superficial veins distended. Sarcoma of the upper extremity of the humerus was diagnosed and amputation performed through the shoulder-joint.

Microscopic examination of the tumour showed that it was evidently a secondary growth. It was then found that the patient had an offensive blood-stained vaginal discharge, and examination revealed the presence of extensive carcinoma of the cervix uteri. The patient died 6 months after leaving the hospital. (*See Surgical Registrar's Report, 1888, pp. 92, 142, 168, No. 1605.*)

- 749.** Portion of a rib, the seat of a secondary deposit of carcinoma. The growth has almost completely destroyed the osseous tissue for a length of about 3.5 cm., and forms a fusiform swelling, over part of which the expanded bone can be traced. The inner surface of the growth is smooth; the outer surface is incorporated with the surrounding muscular tissue. The tumour is soft in consistence; the cut surface is of a reddish-grey colour, with patches, especially in the central part, of a deeper maroon tint. 8026

*Microscopic Structure.*—The tumour is a spheroidal-cell carcinoma. The stroma which encloses the alveoli is very small in amount, the nuclei of the epithelial cells are large and



rounded, and the outlines of the individual cells are in most parts ill-defined. The alveoli are strikingly uniform in size, and nearly all circular in outline.

E. S., aged 56, was admitted into U. C. H., under Mr. Heath, on Feb. 3, 1898, for enlargement of the thyroid, of 4 or 5 years' duration. The growth, which consisted of a thick-walled cyst with masses of thyroid tissue projecting into it, was excised. Readmitted on April 21, 1898, under Mr. Horsley; a large tumour involving the right lobe of the thyroid was removed. Death occurred on the 2nd day. In addition to the deposit in the rib there were large numbers of secondary growths in both lungs and a single one in each kidney. The pituitary body was enlarged.

750. The lower end of a left humerus, with the upper part of the ulna. The humerus has been fractured, with slight obliquity, a short distance above its articular end, at the seat of a tumour which occupies the medullary canal and forms a considerable swelling beneath the periosteum. The tumour is constructed of stiff fibrous bands and lamellæ arranged somewhat vertically to the subjacent bone; the contents of the meshes present in the growth have in great part been removed; in other situations these consist of a pale yellow, homogeneous, friable material.

4588

*Microscopic Structure.*—The tumour is a columnar-cell carcinoma. In many parts the columnar shape of the cells is very perfectly retained, and the cells line definite spaces. In some parts, however, the cells are spheroidal in shape and arranged in solid masses.

From a patient who was admitted, under the care of Dr. Parkes, for cancer of the liver. Fracture of the humerus occurred a month before death. (Dr. Parkes's *Case-book*, Males, p. 239.)

751. The upper part of a left femur in vertical section. Projecting from the inferior aspect of the neck of the bone and the adjacent part of the shaft is a slightly lobulated tumour, which extends downwards a short distance below the level of the small trochanter. Around its anterior border the tumour rises abruptly from the surface of the bone and in its lower part is overhanging. Posteriorly in the position of the intertrochanteric line the bone is distinctly expanded. The section shows that the part of the growth above described is continuous with a central deposit in the substance of the trochanter, neck and head. The compact wall of the bone is wanting in that part of the surface from which the tumour projects. The growth probably originated centrally.

8130

*Microscopic Structure.*—The tumour consists of a delicate connective-tissue stroma enclosing large alveoli most of which are filled with masses of spheroidal-shaped cells. In some alveoli the cells tend to assume a more cubical shape and to form a layer lining the space.

From a man, aged about 65, who had complained of pain in the left hip and thigh for about 6 months. A swelling had been noticed for about 2 months. Amputation at the hip-joint was performed by Mr. Bilton Pollard on Nov. 2, 1898. Until the tumour was microscopied the growth was believed to be a sarcoma. There was no evidence as to the position of the primary tumour. Death occurred shortly after the operation; no *post-mortem* examination was obtained.

752. A longitudinal section of a piece of a rib, which in 2.5 cm. of its length presents a fusiform enlargement produced by a central deposit of squamous carcinoma. A thin layer of the compact wall of the rib can be traced over the tumour.

5428

The deposit in the rib was secondary to a squamous carcinoma of the penis, for which amputation was performed by Mr. Marshall on Jan. 8, 1878. The patient was readmitted on Sept. 13, 1878, with large masses of diseased glands in the groins, the overlying skin on the left side being ulcerated. There was no recurrence in the stump of the penis. Several attacks of hæmorrhage occurred from the left groin, and the patient died on Oct. 5. There was a mass of growth in front of the left sacro-iliac articulation, apparently growing from the periosteum of the ilium. (Mr. Marshall's *Case-books*, 1878, vol. ii. p. 435.)

753. A longitudinal section of part of a rib, which is the seat of a secondary deposit of squamous carcinoma. The growth forms a fusiform swelling, 4.5 cm. in length, and 2 cm. in its maximum thickness. The growth, which has originated centrally, has led to almost complete absorption of the compact tissue in the expanded part of the bone. The cut surface of the tumour is of an opaque yellowish-white colour and closely reticular texture.

6480 A

The primary growth was in the œsophagus.

## WAX MODELS OF TUMOURS OF BONE.

754. A model in wax of an upper arm, into which an incision has been made to display a soft, probably myeloid, sarcomatous tumour arising in connection with the upper end of the humerus. The tumour has completely destroyed the inner parts of the bone; several reddish-black areas of hæmorrhage are scattered over the cut surface. 4088

The patient was a boy, aged 15, a farm labourer. He had never suffered from any previous illness, nor was there any evidence of hereditary predisposition. The tumour continued steadily to increase from its first appearance about five months before admission to the hospital. Before removal the tumour occupied the upper and back part of the arm; above its middle the shaft of the humerus could be felt to bulge; the tumour was soft and yielding, with the exception of one spot on the upper portion, where it was hard as if encased with bone; the skin was not implicated. Before the operation it was feared that the scapula was involved in the disease; after opening the joint, however, this was found not to be the case; the limb was therefore removed by Sir J. Erichsen through the shoulder. The patient was discharged about six weeks afterwards. The growth was found to have arisen within the medullary canal, expanding and destroying the bone confining it; it was distinctly circumscribed by an investment of dense areolar tissue; the neighbouring soft structures were sound.

See, for further details, the 'Medical Times and Gazette,' vol. ii. 1853, p. 324.

755. A wax model of a longitudinal section of seven dorsal vertebræ, the bodies of which were the seat of some tumour, probably a sarcoma. Two of the bodies have been in great measure destroyed, and their remains, flattened and projecting in part forwards and in part backwards, form a slight prominence within the spinal canal. The intervertebral disks are unaffected. The tissues lining the canal as well as the bones themselves are deeply pigmented. 2790

There were several small masses attached also to the loose areolar tissue beneath the dura mater; others were found in the lung.

The sterno-clavicular articulation was the seat of similar disease.

756. A wax model of a left hand and lower third of the forearm, removed by amputation for a tumour which reappeared in the cicatrix after removal of the middle and ring fingers for a similar disease. The tumour forms a flattened globular mass about 3 cm. in diameter, occupying the cleft remaining between the index and little fingers; it was most probably a myeloid sarcoma.

757. A wax model of the left shoulder of a boy, 9 years of age, showing a malignant tumour which involves the outer part of the clavicle. The tumour has a slightly lobulated surface, is somewhat oval or pyriform in shape, and extends transversely in the direction of the clavicle. The growth measures about 7 cm. in length and projects about 3 cm. above the surrounding surface. The sub-cutaneous veins over, and in the neighbourhood of, the tumour are more than naturally evident. 2750

758. A wax model of the same parts, taken six weeks later than the preceding. The growth has increased to at least three times its former size, but preserves an oval, lowly tuberos form. The skin covering the tumour is congested, purple, and red. 2751

759. A wax model of the same parts, showing a still further increase in size of the tumour, which forms a deeply lobulated globular mass about 14 cm. in diameter, and invests the whole of the upper part of the shoulder. The overlying integument is intensely congested and of deepest purple and green: over the summits of many of the lobes the skin has commenced to ulcerate, and hæmorrhage appears to have taken place from the congested ulcerating parts. 2752

760. A wax model of the same parts as are shown in the three preceding specimens, taken after death, eight months from the commencement of the disease, and



eighteen weeks after No. 757. A great portion of the highest part of the tumour, including about its upper third or more, has been destroyed by sloughing. 2753

761. Wax model of a section of the preceding tumour, resting upon the subscapularis muscle, the shoulder-joint, and the upper part of the arm. It appears to have been composed of a very soft, almost diffuent, homogeneous, white or pinkish brain-like substance; the axillary vessels and brachial plexus lie embedded in the growth, parts of which are of a deep purple colour from interstitial hæmorrhage. The tumour was probably a round-cell sarcoma. 2754

#### BONES ALTERED BY THE GROWTH OF TUMOURS.

- (a) *Specimens in which the osseous tissue itself is not invaded by the morbid growth.*  
 (b) *Specimens in which the osseous structure is implicated by the growth of the tumour.*

When a tumour commences superficially on a bone the appearances caused by its pressure are usually exactly similar to those of simple ulceration. The Haversian canals first become enlarged, their walls being consumed by an accumulation of small round cells about the vessels. This process continues till a portion of the osseous tissue is completely destroyed. The small round cells then disappear, and the characteristic elements of the tumour take their place. It is impossible, with any certainty, to distinguish such a specimen, when macerated, from one affected with simple ulceration. If the destruction of bone be very extensive and situated in the shaft of a long bone it is probably due to the presence of a tumour. Malignant growths commencing elsewhere, but implicating a bone in their extension, produce the same effects. Spontaneous fracture may arise if the bone be much eroded. Sometimes, in cases of subperiosteal fibroma, fibro-sarcoma, or even occasionally of spindle-cell sarcoma, instead of destruction of bone taking place, new bone in spiculated masses grows up, forming a sort of skeleton to the tumour (715, 718).

Tumours commencing in the medulla or in the cancellous tissue "expand the bone before them," as it is said—that is, layer by layer the bone is destroyed internally by the pressure of the tumour, whilst at the same time new layers are deposited from the periosteum. The destruction usually exceeds the new production, and consequently after some time the shell of bone becomes so thin as to yield when pressed on, and to give the peculiar sensation known as "egg-shell crackling." Ultimately the shell becomes perforated in many parts, and at these spots the tumour, freed from restraint, grows more rapidly (771).

#### (a) *The osseous tissue itself not invaded by the disease.*

762. A lower jaw, the anterior part of which has become misshapen in consequence of the long-continued pressure of an erectile tumour of the tongue. A considerable part of the alveolar process has been absorbed, and the incisor and canine teeth point directly forwards. The anterior half of the jaw, as is evident from a profile view, is depressed. The teeth, which have been displaced, and upon which the front of the tongue rested, are thickly encrusted with tartar. 3268

The patient was a man 19 years of age. Frequent bleedings occurred from ulcerated parts of the surface of the tumour, which was ligatured. Death resulted from the operation.

#### (b) *The osseous tissue implicated in the disease.*

763. Part of the right side of a skull, in which almost the whole of the petrous and mastoid portions of the temporal bone, with part of the occipital below the groove for the lateral sinus, have been destroyed by a tumour which grew within the skull; the floor of the external auditory meatus has also been destroyed. The cancellous tissue thus exposed is scarcely altered in appearance; the external

table of the bones around the edge of the opening, which is bevelled from the inner aspect, is perforated by minute rounded apertures. 3224

The patient was a man, 20 years of age, in whom the first symptoms of the disease were pain in, and watery discharge from, the right ear. After two years a slight puffiness appeared behind the ear, accompanied by giddiness, unsteadiness in walking, and pain in the back of the head; these symptoms increased, the sight of the right eye being also gradually lost. Fluctuation was felt in the swelling behind the ear; a puncture was made into it, but only a small quantity of blood escaped. Finally the swelling commenced to pulsate, and the common carotid artery was tied by Mr. Syme, in consequence of its compression causing the pulsation to cease. The symptoms were relieved by the operation. On the tenth day, however, pulsation returned, and a swelling appeared in the ear. The patient became gradually weaker and at last comatose, and died three months after the appearance of the external swelling, and one month after the ligature of the carotid, both sight and hearing having been completely lost on the right side.

After death a tumour was found to have destroyed the right side of the base of the skull, viz. half of the sphenoid bone (with the optic nerve) and the petrous portion of the temporal and the mastoid process. The tumour also extended down the neck around the internal carotid artery. The dura mater had been destroyed; the right lobe of the cerebellum, which was gelatinous in consistence and of a pale straw-colour, contained a cavity about as large as an almond and filled with clear fluid.

**764.** A frontal bone, together with the adjoining parts of the nasal, superior maxillary, and ethmoid bones, showing extensive destruction produced probably by the invasion of the osseous tissue by a rodent ulcer of the skin. In the left half of the frontal bone, extending exactly to the middle line, is an irregular opening, measuring 4.5 cm. by 3 cm. The edge of the aperture is in most parts thin and formed by the inner table, the loss of substance in the outer table and diploë being more extensive, so that around the opening, for a distance of 1 cm. or more, the outer surface of the bone is rough and irregularly pitted. The erosion of the outer table extends downwards to the internal angular process, and involves the inner half of the upper margin of the left orbit and the adjacent part of the nasal process of the left superior maxillary bone. Seen from within, the bone around the aperture is slightly more porous than natural.

**765.** The bones of a face, with the adjoining parts of those forming the cranium. In consequence of some malignant disease, probably squamous carcinoma, commencing in the soft parts, the alveolar portion of the left superior maxilla has been wholly destroyed, and the antrum, after complete destruction of its floor, opens by a wide triangular aperture into the mouth. The neighbouring margin of the palatine process has for a part of its thickness been removed, its cancellous tissue being opened by the inward spread of the disease. The under border of the lower jaw is scalloped and deeply pitted, and behind the situation of the left mental foramen the new growth has penetrated the dental canal. The cancellous tissue in all these situations is uniformly exposed. Thin patches of new bone have been formed on the inner surface of the lower jaw over its middle and left side, and similar bone upon the outer surface of the left ramus. 3253

**766.** A skull, the facial part of which has been extensively destroyed, probably as the result of a tumour occupying the nasal fossæ. The nasal bones, the nasal processes of the superior maxillary bones, the internal angular processes of the frontal, the lacrymals, the vomer, the greater part of the ethmoid, and the inferior turbinate bones, together with the palatine processes, have disappeared. On the left side the upper jaw is pressed backwards into the form of a flattened plate of bone, with which the malar bone, which is also much reduced in size and pressed backwards, retains its normal relations; only the posterior extremity of the alveolar process is recognizable. On the right side the upper jaw presents similar but much less marked changes, the antrum retains its shape though reduced in size, and the alveolar border corresponding to the sockets of the last two molar teeth is normal. As the result of the above changes a deep tunnel passes from before backwards between the orbits; the bone bounding it is tuberculated, and in its roof are seen openings into the right frontal sinus and the sphenoidal sinus.



The front part of the alveolar border of the lower jaw is atrophied and everted, so that the teeth must have projected almost directly forwards. The remaining teeth, especially the first bicuspid of the left side, have a similar inclination forwards.

4991

The alterations in the bones appear to have been the result of the pressure of a large tumour rather than of destruction of the osseous tissue by an infiltrating growth. There is no history to the specimen.

**767.** The upper end of a child's left humerus, together with the scapula and clavicle. Of the last a small, irregular, and atrophied portion of the shaft is all that remains, the rest having disappeared before the growth of a malignant tumour, which has implicated its structure. The other bones are exceedingly atrophied; the upper part of the scapula is coated with a delicate layer of minutely porous new bone. 4952

**768.** Parts of a radius, the shaft of which has almost wholly disappeared, in consequence, probably, of the growth of some tumour within it. The portion of its lower end shown is considerably enlarged by the formation of new bone upon it.

1052

**769.** The bones of a left hand. A considerable part of the outer side of the second metacarpal bone, and a portion of the distal extremity of the first, together with the proximal half of the first phalanx of the thumb, have disappeared before the growth of some tumour which has implicated their substance, the cancellous tissue being exposed.

1917

**770.** A left femur, the whole length of which from below the level of the great trochanter down to the lower extremity has been greatly distorted by the growth of a large tumour within the shaft. In its lower half the latter is represented by an irregular spiral column of bone about 2 cm. in width; in its upper half the shaft is similarly deformed, but irregular flattened processes of bone project from it and are arranged in a manner which suggests that they surrounded the central tumour. The head of the bone is unaltered, but the neck and great trochanter, although not expanded, have been almost completely hollowed out by an extension of the growth into them. The lower extremity of the bone is normal. The length of the bone is much diminished, and the lower extremity is rotated outwards. 1050

**771.** A longitudinal section of the lower two-thirds of a right femur, patella, and upper end of the tibia. By the growth of a large cystic sarcomatous tumour within it the articular extremity of the femur and the lower part of its shaft have been expanded into a great globe-like shell 15 cm. in diameter; in several situations this is perforated with large irregular fenestræ; in other parts it is much thickened, in some places measuring more than 1 cm. The patella is displaced forwards, and united to the anterior and lower part of the osseous shell, upon which it rests; the latter has become continuous also with the upper surface of the head of the tibia. The medullary canal of the femur is closed by a layer of compact bone, which completes the continuity of the shell in this situation. The knee is slightly flexed.

4985

This specimen illustrates very well the condition called "expansion" of bone by the growth of a tumour within it. The original substance of the bone is really absorbed as the result of the pressure from within, and new osseous tissue is formed from beneath the periosteum. In the subsequent growth of the tumour this is in turn absorbed and replaced by a new layer. By this double process of growth and absorption the femur has come to assume its present form. At parts the new formation has been in excess of removal, the new bone being thicker even than the normal wall of the femur; in other situations formation has not advanced commensurately with absorption, and here thinly edged openings of various sizes exist in the new osseous shell.

**772.** The upper three-fourths of a right fibula, in which the upper end and adjoining part of the shaft for about 8 cm. have been expanded into a globular shell by the formation of some tumour within them. The expanded portion is in places very thick and firm, in part, apparently, from ossification of the peripheral

portion of the tumour itself. The articular surface of the head of the bone is still recognisable. The medullary canal is closed by a thick mass of very dense osseous substance. 3110

73. An irregularly elliptical portion of a calvaria, measuring 11 cm. by 8 cm. in its two chief diameters. The narrow extremities of the piece of bone are formed by sawn surfaces 3.5 cm. in length. Around the rest of its margin the specimen presents a somewhat irregular border, which is in parts sharp and toothed, and in others thick and rounded, and in almost all parts covered with a layer of compact bone formed as the result of healing. From the outer surface of the bone rises a rounded osseous growth, 7 cm. in diameter, around more than half of the border of which is the mark of a deep saw-cut. The surface of the bony growth is in parts even, and in others marked by shallow, slightly rough depressions; it is at all parts formed of compact bone, which is very regularly marked by small rounded openings, giving the whole a cribriform appearance. The margins of the tumour shelve off gradually on to the surrounding surface of the skull.

On the inner surface of the specimen, to an extent corresponding to that of the tumour externally, the inner table is replaced by closely-set bony lamellæ, arranged vertically to the surface, and ending for the most part in sharp edges or points. Around this surface the inner table is smooth and very dense. The normal curvature of the inner aspect of the bone is unaltered. 7547

Removed by Mr. Victor Horsley from a woman aged 40, who suffered from epilepsy. The patient was a "bleeder," and the operation was performed in five stages, by cutting a groove around the affected portion of the skull.

774. Part of an irregularly circular portion of a skull, 7.5 cm. in diameter, removed by operation from the right fronto-parietal region. The margin of the bone is marked by five semicircular notches, and between these by sawn surfaces. The outer surface of the bone is considerably raised above the normal level, and a section shows that at its centre the bone has a thickness of 22 mm., the thickness gradually diminishing from the centre of the specimen until at its border the bone is at most parts not thicker than natural. The outer surface of the bone is nearly covered with a firmly adherent fibrous layer, and where this is absent the bone is seen to be dense and marked by minute openings. The section of the thickened bone shows it to be uniformly dense in structure, all distinction between the tables and diploë having disappeared. The inner table is normal in the greater part of its extent, but in the centre of the specimen the inner surface of the bone is slightly raised, and in this situation the inner table is wanting, and a thin layer of soft friable tissue is intimately adherent to and appears to invade the deepest part of the thickened bone. 8058

*Microscopic Structure.*—A section of the thickened bone shows that the trabeculae are thick and the intervening spaces small. In the deepest part of the bone the spaces are filled with small oval cells, among which are thin-walled blood-spaces, and in the more superficial parts with a loose fibrous tissue.

H. B., a man aged 25, was admitted into U. C. H. March 1, 1898. Ten years previously a small lump was noticed on the right side of the forehead. Four years later he was admitted into the Great Northern Central Hospital under the care of Mr. Raymond Johnson, after having had "a fit on the left side." In the right fronto-parietal region there was a circular thickening of the skull of the extent shown in the specimen. The swelling, which was regarded as an osseous tumour, was exposed by operation and the periosteum completely removed from its surface, with the object of preventing its further growth. Double optic neuritis developed, and a month after the first operation the portion of bone preserved in the specimen was removed by the use of a trephine and saw. The outer surface of the dura mater was involved in a soft irregular growth which was not removed. When admitted into U. C. H. six years later the patient was nearly blind and there was atrophy of both optic discs. At the seat of the operation there was a prominent swelling presenting a bony margin and soft centre. Whilst the patient was in the hospital two fits occurred, the convulsions beginning in the left side of the face and spreading to the left arm, left leg, and right arm. No further operation was attempted. (Mr. Godlee's *Case-books*, 1898, vol. i. p. 54.)



## INJURIES AND DISEASES OF JOINTS.

## SERIES I.—DISLOCATIONS.

According to their causation, dislocations are divided into :—

*Traumatic*—occurring in a healthy joint as the result of mechanical violence (800).

*Spontaneous or Pathological*—in which the dislocation occurs in a diseased joint, usually as the result of some slight injury, which would have been insufficient to dislocate a healthy articulation. The most important conditions which lead to spontaneous dislocation are softening of the ligaments and destruction of the articular surfaces (775); distension of the joint with serous or purulent effusions; and the formation of bony or cartilaginous outgrowths displacing the bones.

*Congenital*—due to arrest of development of the articular surfaces, or possibly sometimes to injury or disease of the joint before birth.

Dislocations are also divided into *Complete*, in which the articular surfaces are completely separated one from the other (801); and *Partial*, in which, although displaced, some parts of the articular surfaces are still in contact.

As in the case of fractures, traumatic dislocations are divided into :—

*Simple or closed*—when the injury is unaccompanied with any wound of the soft parts communicating with the surface.

*Compound or open*—when the injured joint communicates with the surface by a wound (795).

*Complicated*—when the displacement is associated with some important injury to the neighbouring structures, as, for instance, when one or both of the displaced bones are also fractured.

In a recent dislocation it will be seen that the ligaments uniting the two bones are more or less torn, and in many cases the surrounding muscles are also lacerated. The position of the displaced bone is determined partly by the direction in which the force has been applied to it, and partly by the direction in which it is pulled by the muscles attached to it.

In an old unreduced dislocation various changes occur both in the joint itself and in the surrounding structures. The hollow articular cavity becomes shallow and flattened, partly by absorption of its prominent margins and partly by filling up from the bottom (777). The displaced articular head undergoes more or less alteration in shape (788), and an imperfect new articular cavity is formed to receive it in its new situation. This is accomplished by the formation of a rim of new osseous tissue around the part of any bone against which the displaced articular extremity may rest (776). New ligamentous tissue is formed to hold the bone in its abnormal position, and is usually intimately connected with the surrounding structures. The cartilage disappears from both articular surfaces, being replaced by dense fibroid tissue, which may form firm adhesions to surrounding structures, as vessels, nerves, &c. In the centre of the new articular cavity the fibroid tissue may be wanting, and the bone may become excessively smooth, hard, and polished, and the same change may occur on the corresponding part of the displaced bone (777).

**775.** A right hip-bone, with the upper part of the femur, in which dislocation of the hip had resulted from disease of the joint. The head of the femur is quite flat above, its articular surface looking almost wholly upwards. The new surface is irregular; in places its cancellous tissue is open, but dense and hard; in others the cancellous spaces are occupied by osseous substance of great density; and in

one situation there is a small eburnated spot. The surface of the compact tissue of the neck has been destroyed by more recent ulceration as far as the attachment of the capsule; beyond the limits of the capsule soft spongy bone of recent formation in many places exists on the shaft of the femur. The acetabulum is increased in size, and for the most part its surface is ulcerated, the cancellous spaces of the bone being widely open, but near the posterior margin, and also in front, a small fragment of the original surface remains; both these portions are eburnated. The head of the femur was dislocated on to the external surface of the ilium above and behind the acetabulum; the bone upon which it rested is scarcely changed, but a ridge of osseous substance has been formed above, apparently to reproduce an articular cavity. Irregular nodular masses of new bone have also been formed above the anterior inferior iliac spine, and from that point on to the ilio-pectineal eminence, and a thin layer of new bone, part of which has become compact, lines the iliac fossa, and extends downwards over the inner aspect of the bone corresponding to the position of the acetabulum. In the recent state the acetabulum was partly filled with "pultaceous matter."

4752

The history is vague and uncertain. The patient's wife stated that he had enjoyed good health till eleven weeks before death, when he had an attack of "rheumatic fever," the hip-joint becoming then first affected. She stated, also, that the dislocation had taken place six weeks before his death, whilst she was assisting him out of bed, and that before that he could walk. An abscess formed over the region of the hip-joint, for which he was admitted under Sir John Erichsen's care. He died of adynamic pneumonia. It is probable that the head of the bone had been altered in shape, possibly in consequence of rheumatoid arthritis, previously to the acute attack of inflammation which led to the dislocation.

776. Part of a left hip-bone, upon the iliac portion of which the upper end of the femur has at some time been dislocated. In the situation noticed, and immediately above the acetabulum, a new articular cavity has been formed, in part by absorption of the natural bone and in part by the formation of a prominent ring of new osseous tissue around the new articular surface. The surface of this cavity is for the most part smooth and dense, and before maceration was probably coated with a layer of very close fibroid tissue. The acetabulum itself is deep, contracted and oval in form; its interior is lined with a thin compact osseous layer.

3043

777. The hip-bones of an old woman, showing changes which have followed dislocation of both femora. On the outer surface of the left ilium, above the acetabulum, there is an almost circular area, about 5 cm. in diameter, slightly lower than the bone around, and surrounded by a low slender border of new bone. The adventitious articular surface reaches from the margin of the great sciatic notch behind to about 2 cm. from the anterior inferior iliac spine in front, and from the inferior curved line above to the situation of the acetabulum below; over its centre the surface is eburnated. The acetabulum itself is diminished in size and triangular in form.

In the right hip-bone the acetabulum presents changes very similar to those noticed in the left; but the surface of the ilium above the acetabulum is merely roughened by an irregular deposit of new bone; and the parts do not present such distinct evidence of the formation of a new articular surface as exists on the other side.

3046

#### DISLOCATIONS OF THE SPINAL COLUMN.

Many specimens illustrating displacement of the vertebræ resulting from fracture of the vertebral column are preserved in the series of Fractures and Fracture-dislocations of the Spine (p. 34).



Dislocations of the vertebræ unaccompanied by fracture are very rare. When met with they are generally in the lower part of the cervical region, and the displacement is usually such that the head with the upper vertebræ is carried forwards, whilst the lower articular processes of the vertebra above the line of displacement are locked in the upper notches of the vertebra below (779).

Lateral or even backward displacement may, however, occur. Dislocation may also occur between the atlas and axis, the former being usually displaced forwards with or without fracture of the odontoid process (778); dislocation has also been met with between the atlas and the occipital bone.

Dislocation is exceedingly rare in the dorsal region, and, except in association with fracture, has never been met with in the lumbar region.

- 778.** Two wax models, giving an upper and a lower view of a complete dislocation of the atlas forwards and to the right side, after fracture of the odontoid process of the axis. The arch of the atlas, which is wanting, was also transversely fractured through its pedicles. 2509

From a man, aged 32, who fell off a hayrick on to the back of his head. He was stunned, but was soon able to walk home. His only complaint was a feeling of stiffness in the neck. Between three and four weeks later he was examined by Mr. Benjamin Phillips, F.R.S., who found swelling and tenderness over the second cervical vertebra, which he regarded as due to "chronic inflammation of a scrofulous character." Treatment consisted of rest and the application of leeches, and afterwards in the use of issues. Many weeks later there was thickness of the voice and slight difficulty in swallowing, and examination of the pharynx showed the presence of a projection at the level of the 2nd cervical vertebra. Death occurred nearly a year after the accident from general anasæra following an attack of pleurisy. "The condyles of the occiput still rested upon the articulating surfaces of the atlas." The displaced portion of the atlas was firmly ankylosed to the axis, and the absence of pressure upon the spinal cord depended upon the displacement of the detached odontoid process forwards with the atlas. (Trans. Royal Medical and Chirurgical Society, vol. xx. 1836, p. 78.)

- 779.** The vertebræ of the cervical, with the first of the dorsal region. The fifth cervical vertebra has been dislocated forwards from the sixth, its lower articular processes lying locked in the upper notches of the sixth cervical vertebra, in which situation the sixth pair of spinal nerves must have been firmly compressed; as the result of the displacement the spinal canal is considerably encroached upon. 3606

From a man who fell down stairs whilst carrying a sack of flour. He was taken up insensible, and died soon after he was taken to the hospital. The dislocation is at a point below the exit of the nerves of the cervical plexus, hence the parts supplied by these nerves, including the diaphragm, must have escaped paralysis.

- 780.** An axis with the four succeeding vertebræ. The fourth cervical vertebra has been dislocated forwards, its lower articular processes lying, as in the preceding specimen, within the upper notches of the vertebra next below. The arches of the vertebræ have been removed to display the spinal cord, the substance of which appears to have been crushed at the seat and in the neighbourhood of the displacement.

In this specimen the cord is injured above the origin of the phrenic nerve, and there would have resulted, in consequence, complete paralysis of all the muscles of respiration, leading to almost instantaneous death.

## DISLOCATIONS OF THE JOINTS OF THE UPPER LIMB.

*Dislocations of the Sterno-clavicular and Acromio-clavicular Joints.*

The *sternal end* of the clavicle may be dislocated forwards—often with a slight displacement upwards or downwards (781)—or much more rarely backwards.

Dislocation of the *acromial end* of the clavicle upwards is not uncommon; dislocation downwards is exceedingly rare.

**781.** Plaster cast of the upper portion of a thorax, with parts of the left shoulder and root of the neck, showing a dislocation of the sternal end of the clavicle forwards upon the manubrium sterni. In consequence of the displacement of the clavicle the clavicular portion of the sterno-mastoid is very evident at the root of the neck, and the supraclavicular fossa is increased in extent.

*Dislocations of the Shoulder-joint.*

The humerus may be dislocated forwards and inwards beneath the coracoid process—subcoracoid dislocation (782), or beneath the clavicle—subclavicular dislocation; downwards beneath the glenoid cavity—subglenoid dislocation (783); or backwards beneath the spine of the scapula—subspinous dislocation (785).

The most important signs which are common to all dislocations of the shoulder are:—(1) Flattening of the shoulder and undue prominence of the acromion (782); (2) limitation of movement; (3) increase in the vertical measurement of the axilla (783); and (4) abduction of the arm. The varieties differ in (1) the effect on the length of the limb; (2) the direction of the long axis of the arm (785); and (3) the position of the prominence caused by the displaced head of the humerus (782, 785).

**782.** Plaster cast of a left shoulder, with the adjoining parts. About 4 cm. below the clavicle and 5 cm. to the inner side of the acromion is a smooth globular swelling formed by the head of the humerus, which has been dislocated forwards to the inner side of the coracoid process, but is separated by a considerable interval from the lower border of the clavicle. The deltoid is flattened, or even slightly depressed, in the situation naturally occupied by the upper end of the humerus. The arm is considerably abducted. The pressure of the displaced bone upon the axillary vessels is shown by the fulness of the cephalic vein.

401

**783.** Plaster cast of a right shoulder, in which the head of the humerus was dislocated downwards into the axilla (subglenoid dislocation). The acromion is more prominent than natural, but there is no obvious protrusion of the parts, either in front of or behind the shoulder; the lower border of the anterior fold of the axilla is somewhat further removed from the clavicle than on the opposite side.

**784.** Plaster cast of the left shoulder from the same person.

**785.** Plaster cast of a right shoulder and the adjoining parts. Behind the situation of the acromion and below the outer end of the spine of the scapula is a rounded prominence, resulting from a dislocation of the upper end of the humerus backwards upon the body of the scapula (subspinous dislocation); the parts immediately below the acromion are markedly depressed. To the inner side of the acromion and a short distance below the clavicle the coracoid process is plainly recognizable. The spine is considerably bent forwards.



**786.** A scapula and clavicle, the former exhibiting changes resulting from a dislocation of the head of the humerus, which has remained unreduced. The margins of the glenoid fossa have become smoothly rounded by absorption, its cartilage has disappeared, and in places new bone has been formed upon it so as to render it uneven; and, as an articular cavity, the fossa has ceased to exist. Both the bones are wasted from disuse. 2005

**787.** A scapula, in which the coracoid process has been rendered on its lower surface evenly concave so as to form part of an adventitious socket, after a dislocation of the humerus, which has remained unreduced. The bone in the situation noticed is deeply pitted as if worm-eaten, and its surface polished. Irregular, overhanging, nodulated masses of bone have been formed both upon and around the glenoid fossa. 392

The dislocation may have happened in consequence of changes in the joint resulting from rheumatoid arthritis.

**788.** Plaster cast of the bones entering into the formation of a right shoulder-joint. The shape of the glenoid cavity and of the head of the humerus has been altered as the result of an unreduced subcoracoid dislocation. The anterior part of the glenoid fossa has been worn away so that its border has been rendered quite straight. A corresponding alteration has occurred in the posterior part of the head of the humerus, which presents a flat surface as though a thick slice had been removed from the bone; this surface lay in contact with the anterior border of the glenoid fossa and the front of the neck of the scapula. 5970

#### *Dislocations of the Elbow-joint.*

The most common dislocation of the elbow-joint is that in which the upper extremities of the radius and ulna are displaced backwards (792), whilst as varieties of the backward displacement inward or outward dislocations are occasionally met with (793). Dislocations of both bones forwards without fracture of the olecranon is almost unknown. The most common dislocation of one bone only is that of the head of the radius forwards (790). Dislocation of the ulna alone in a backward direction may occur, or the ulna and radius may simultaneously be displaced in opposite directions, the ulna backwards and the radius forwards (789).

**789.** Plaster cast of the left elbow of a boy, fourteen years of age, showing appearances due perhaps to a dislocation of the upper end of the ulna backwards and of the radius forwards. The olecranon is unnaturally prominent, and above it is a wide shallow depression, resulting from the displacement of the ulna backwards. The forearm is almost fully extended, semipronated, and slightly bent inwards. In this position of the parts the inner condyle of the humerus is situated almost in the same transverse plane as the olecranon. There is a shallow depression in the proper situation of the head of the radius, and the front of the elbow on the outer side is fuller than natural.

**790.** Plaster cast of the forearm and hand with the lower part of the upper arm, of a child, in which the head of the radius was dislocated upwards on the front of the humerus. In the natural situation of the head of the radius there is a deep depression, and the parts on the front and outer side of the elbow are fuller than natural. The cast has been taken with the elbow flexed as far as the altered relations of the parts permitted, the angle of extreme flexion being exactly a right angle; in this position the head of the radius lies against the lower part of the humerus immediately above the capitellum.

**791.** Plaster cast of the corresponding parts of the opposite limb of the same patient, the forearm being flexed to the full natural extent; the angle of flexion is about 45°.

**792.** The bones of an elbow-joint, in which a backward dislocation of the radius and ulna has at some time occurred, the dislocation remaining unreduced. The coronoid process of the ulna, smoothly rounded, rests on the back of the trochlea of the humerus, which is correspondingly hollowed to receive it. Behind the head of the radius a pointed process of new bone has been formed upon the humerus, which would prevent further backward displacement of the radius. The lower end of the humerus is greatly altered in shape, its trochlear portion being almost entirely wanting; the inner condyle is much less prominent than natural.

**793.** Plaster cast of a right elbow, showing the deformity resulting from dislocation of the bones of the forearm backwards and inwards. The most noticeable features are the increased width of the elbow, the undue prominence of the external condyle, the presence of a deep hollow in the natural position of the internal condyle, and lastly, the marked projection formed by the olecranon on the inner and posterior aspect of the joint, above which is a vertical ridge corresponding to the inner border of the tendon of the triceps.

The dislocation resulted from a fall on the arm many years previously. Complete extension of the elbow was impossible; passive pronation and supination were free.

**794.** The lower end of a right humerus, together with the forearm bones. The upper extremity of the radius is dislocated backwards, and the bone lies in a position of extreme pronation. The head of the radius is shrunk, and lies on the outer border of the great sigmoid cavity, and presents a small articular surface which plays against the humerus. For a distance of 7 cm. the upper end of the radius is firmly ossified to the corresponding part of the ulna. The latter occupies its normal position, and the only noticeable change in the lower end of the humerus is the small size of the capitellum. Below the level at which the two bones are fused the ulna is markedly atrophied, whilst the radius appears to be stouter than natural.

There is no history to the specimen.

#### *Dislocations of the Wrist-joint and Carpus.*

Dislocations of the wrist-joint are exceedingly rare, and most commonly are complicated with fracture of the lower end of the radius or of the styloid process of the ulna, in which case the dislocation may be compound (795). A simple uncomplicated dislocation of the carpus may, however, occur backwards, or still more rarely forwards (797). Dislocations of the individual carpal bones are also exceedingly rare, the most common being a displacement of the os magnum backwards.

**795.** The lower part of a right forearm and hand, removed by amputation for compound dislocation of the wrist, associated with fracture of the lower end of the radius and ulna. Across the posterior aspect of the limb, above the level of the wrist-joint, there is a nearly transverse wound nearly 10 cm. in length. In its inner half the wound gapes widely, and through it parts of the lower extremities of the forearm bones project for a distance of 2.5 cm. The projecting part of the ulna includes the whole of the lower extremity except the styloid process, which has been detached through its base. The projecting portion of the radius is represented by the lower end of the shaft, which has been completely separated by an oblique fracture from its articular extremity. The hand is carried forwards to a right angle with the forearm.

7775

From a woman, aged 59, who fell down a flight of stairs. The dislocation having been reduced, the wound was closed with sutures. Cellulitis of the limb followed, and on the



second day the patient was sent to U. C. H. Two days later Mr. Heath performed amputation below the elbow. Death occurred five days after the operation. The patient was constantly delirious, and the temperature, which varied between  $102^{\circ}$  and  $103^{\circ}$ , rose to  $106^{\circ}$  before death. The tissues around the seat of injury were infiltrated with a thin, brownish, foul-smelling fluid, and pus escaped from the medullary cavity of the radius. (Mr. Heath's *Case-books*, 1897, vol. i. p. 430.)

**796.** Plaster cast of the hand and forearm, from a case in which a dislocation occurred either at the articulation between the first and second rows of carpal bones, or at the carpo-metacarpal articulation. There is a marked rounded dorsal prominence in the position of the carpus, and a palmar prominence corresponding, so far as can be detected from the cast, to the base of the metacarpal bones.

**797.** Plaster cast of the lower half of a right forearm, with part of the hand, from a patient in whom the wrist had been dislocated for twenty years, the displacement having occurred forwards. The articular ends of the radius and ulna project prominently beyond and above the carpus. The ends of the bones appear to have undergone some alteration in shape and are rounder than natural, but they are clearly traceable and preserve their proper mutual relations. The wrist is slightly flexed and the tendons of the flexor carpi ulnaris and palmaris longus stand out prominently on the front of the joint. 4147

#### *Dislocations of the Phalanges.*

The most important of these is the dislocation of the first phalanx of the thumb backwards (798). It derives its interest from the great difficulty often experienced in reducing it.

Dislocations of the second phalanx from the first (799), or the unguis phalanx from the second, occasionally occur.

**798.** Plaster cast of a right hand, showing the configuration of the parts after a dislocation of the first phalanx of the thumb backwards upon the metacarpal bone. The first phalanx is over-extended so as to form almost a right angle with the metacarpal bone, upon the neck of which it rests; the terminal phalanx is semi-flexed. The rounded prominence of the head of the metacarpal bone is readily distinguishable in front of the dislocated phalanx. The ball of the thumb is flattened from the lower ends of the short muscles having been carried backwards with the base of the displaced phalanx, the head of the metacarpal bone projecting forwards between them.

**799.** Plaster cast of a left hand, in which the second phalanx of the middle finger had remained dislocated on the palmar surface of the first for three months. The interphalangeal joint is slightly flexed, the lower part of the finger being also twisted outwards.

The unnatural prominence of the head of the first phalanx and the shallow depressed space below it remain to mark the nature of the injury.

#### DISLOCATIONS OF THE JOINTS OF THE LOWER LIMB.

##### *Dislocations of the Hip-joint.*

Dislocations of the hip-joint are divided into regular dislocations—in which some part at least of the ilio-femoral ligament remains intact,—and irregular dislocations, in which the ilio-femoral ligament is completely torn. The regular dislocations are divided, according to the direction in which the head of the femur passes,

into:—(1) dislocation backwards, the head of the bone passing above or below the tendon of the obturator internus (800); (2) dislocation downwards on to the thyroid foramen (801); and (3) dislocation forwards on to the pubic bone.

In dislocations of the upper extremity of the femur backwards the limb is inverted, and there is a varying degree of flexion and adduction with shortening. In the dislocations forwards or downwards the limb is abducted with a varying degree of flexion and eversion; in the pubic dislocations the limb is shortened, but in the thyroid dislocations there may be considerable apparent lengthening.

**800.** The bones entering into the formation of a right hip-joint, together with some of the surrounding muscles, showing a dislocation of the head of the femur backwards below the tendon of the obturator internus. The femur is flexed, adducted, and rotated inwards, and its head rests on the bone between the posterior border of the acetabulum and the tuber ischii. The great sciatic nerve has been drawn inwards in order more completely to expose the head of the bone. The ligamentum teres is torn almost completely through, a piece of glass-rod being placed beneath the small band which alone remains intact. Above the neck of the femur is a bony fragment which has been detached from the border of the acetabulum, and remains in connection with the capsule. Immediately below the head of the bone is the quadratus femoris, the upper border of which is slightly lacerated. The inferior gemellus is entirely torn through. Above the dislocated head lie the obturator internus and superior gemellus, which are intact. The laceration of the pyriformis was probably produced in preparing the specimen. 5938

From a man, aged 55, who, whilst getting into a railway-carriage, fell between the footboard and the platform. He was admitted into U. C. H. in a condition of severe shock and suffering from an extensive smash of the left thigh and leg. There was a dorsal dislocation of the right hip, and grating could be felt about the upper part of the femur. Amputation was performed through the left thigh; reduction of the dislocation of the hip was effected by Bigelow's method; death occurred a few hours after the operation. There was extensive extravasation of blood about the inner part of the right knee; the internal lateral, posterior crucial, and part of the anterior crucial ligaments were torn through. (Mr. Heath's *Case-books*, 1883, vol. ii. p. 646.)

**801.** Plaster cast of the bones forming a left hip-joint. The head of the femur has been dislocated downwards into the thyroid foramen, and the femur is represented in a position of slight adduction and eversion. The acetabulum appears to have been diminished in size by the formation of new bone within it; and an abundant formation of bone has taken place from the superior ramus of the pubis above the thyroid foramen, and appears to have formed part of an adventitious articular cavity for the dislocated head of the femur. The deepest part of this cavity forms a low projection within the pelvis. There is a well-defined, slightly curved ridge between the acetabulum and the head of the femur, apparently the divided edge of a new articular capsule.

**802.** Plaster cast of part of a right hip-bone, upon the anterior border of the iliac portion of which the head of the femur has been dislocated (subspinous dislocation), the dislocation having remained unreduced. A new articular cavity has been formed in this situation, in part, apparently, by absorption of the anterior portion of the ilium, but chiefly by the formation of a prominent semicircular ridge of new bone on the inner surface of the ilium around the dislocated head of the femur. The new socket closely resembles the natural acetabulum, except that it is more incomplete in its lower part than is the acetabulum in the situation of the cotyloid notch.



*Dislocations of the Patella.*

These are rare. When met with the bone is generally displaced outwards (803). This dislocation is favoured by the presence of genu valgum. It is occasionally congenital, and may then be associated with imperfect development of the lower extremity of the femur, especially the external condyle. Internal dislocation of the patella is exceedingly rare. Occasionally the bone becomes twisted so that either the inner or outer margin rests in the groove between the condyles of the femur (804); reduction may then be difficult. In rare instances, the bone may be so completely rotated that its cartilaginous surface is directed forwards. Dislocation of the patella upwards can only occur as a result of rupture of the ligamentum patellæ.

803. Plaster cast of a left knee, in which the patella has been completely dislocated outwards, the joint being semiflexed. In the natural situation of the patella there is a shallow triangular depression. The patella appears to lie with one of its borders directed outwards and slightly forwards, the opposite being directed towards the ham; from its lower end a thick prominent ridge, caused apparently by the ligamentum patellæ, passes obliquely forwards towards the tubercle of the tibia.

804. Plaster cast of a left knee, taken in the extended position. The patella has been partially dislocated outwards, and rotated so as to lie edgewise on the middle of the patellar surface of the femur.

From a man aged 36. While wheeling a barrow his left foot slipped on a small stone. He immediately felt a sensation of a bone grating over another in his left knee, which was slightly twisted and bent inwards. He at once became very dizzy and fell to the ground.

*State on admission.*—The left leg is extended and cannot be flexed. There is scarcely any swelling of the knee, and only a little bruising in a hollow near the middle of the knee. The knee looks widened. Near the centre of the knee, a little more towards the inner than the outer side, is a hollow corresponding to the hollow between the condyles of the femur, and between that bone and the head of the tibia. Near the outer side of the hollow, with the inner border dipping into it, is the patella, the outer border of which is tilted forwards and outwards, being visible as a large protuberance on the outer side of the limb. Above this hollow can be felt the fleshy mass of the lower end of the vastus internus, which appears to be very tense. Below the hollow can be felt the head of the tibia. The patella is on the outer side of the limb, with its outer edge tilted forwards and outwards and its inner edge in the hollow between the condyles of the femur. It is in fact twisted upon itself, so much so that it lies in a plane at an angle of about 60° with its normal plane. Its under surface can be clearly felt, and its smooth articular surface recognized. The anterior surface can be recognized by its roughness; it is directed forwards and inwards, and the posterior backwards and outwards. The tendinous insertion of the rectus can be felt to be very tense and rigid. The ligamentum patellæ is not so tense as would have been expected.

The patient is a strong fine man, with no tendency to knock-knee.

The patella was easily reduced under chloroform by pressing on the outer edge and flexing the knee. Slight effusion into the joint followed, but the patient was well enough to be dismissed from the hospital, wearing a leather splint, on the sixth day after admission.

805. Plaster cast of a left knee, showing a dislocation of the patella outwards. The patella lies on the outer side of the knee, much in the same position as in the specimen first described. The dislocation was of long standing. 4325

806. Plaster cast of the same knee taken in the extended position.

807. Plaster cast of the right knee of the same patient, in a position of semiflexion.

*Dislocations of the Knee-joint.*

From the great width of the articular surfaces and the strength of the ligaments, dislocations of the knee are only caused by severe violence, and are usually

incomplete. They may occur in any direction, most commonly laterally. Displacement of the head of the tibia backwards is a not uncommon result of long standing disease of the knee-joint (1043 *et seq.*).

Dislocation of a semilunar cartilage, generally the internal, is not uncommon. The injury usually results from a sudden twist of the joint, and the fibro-cartilage may be torn away from one of its attachments to the tibia, or it may be separated from its attachment to the capsule and occupy a vertical position in the intercondylar fossa (808).

**808.** A right knee-joint from which the capsular ligament has been removed. The circumference of the external semilunar fibro-cartilage has been torn away from its attachment to the capsule, and has been dislocated inwards so as to occupy a vertical position in the intercondylar fossa, lying between the external condyle and the anterior crucial ligament. The articular cartilage of the femur and tibia is in parts rough and fibrous, and in parts eroded as the result of rheumatoid arthritis.

From the dissecting-room. ('Illustrated Medical News,' Sept. 29, 1888, p. 9.)

### *Dislocations of the Ankle-joint and Tarsus.*

The whole foot may be dislocated from the bones of the leg. The dislocation may be complete in a direction backwards (809) or forwards, or incomplete in either lateral direction; but in all cases of complete lateral dislocation and almost all antero-posterior dislocations the injury is accompanied by fracture of one or both malleoli (810).

Dislocations of the astragalus alone are not uncommon. The bone is most frequently displaced forwards and outwards, the head forming a marked projection on the dorsum of the foot (812). This dislocation may be compound (811), and may be complicated by fracture of the displaced bone (814).

In subastragalar dislocations, the astragalus retains its normal position within the malleolar arch, whilst the rest of the foot is displaced, most commonly in a direction backwards, with at the same time an inclination inwards or outwards.

**809.** A left foot dissected, together with the lower part of the bones and muscles of the leg and a portion of skin from the region of the ankle. A complete dislocation has occurred at the ankle-joint without fracture. The foot is displaced upwards, backwards, and inwards, whilst the lower extremities of the tibia and fibula project through a large wound in the integument on the antero-external aspect of the limb. The only damage recognisable in the displaced bones is a depression in the anterior part of the articular surface of the tibia. As a result of the dislocation, the various structures in relation with the ankle-joint have been much displaced. Thus the tendons passing to the dorsum of the foot, together with the anterior tibial artery, lie on the inner side of the internal malleolus between it and the displaced astragalus. On the inner side, the remains of the internal annular ligament, together with the tendons of the tibialis posticus and flexor longus digitorum, are tightly stretched across the astragalus; whilst the tendon of the flexor longus hallucis and the posterior tibial vessels and nerve lie in a deep groove between the astragalus and os calcis. The tendo Achillis is relaxed. The peroneal tendons have been torn from the back of the fibula, and retain their normal relations to the outer surface of the os calcis.

There is no history to the specimen.

**810.** Plaster cast of a left foot and lower half of the leg, from a case in which the foot was subluxated inwards, the inner malleolus being also fractured. The foot is



-- displaced but little inwards, but is considerably inverted, its plantar surface looking as much inwards as downwards. The lower end of the fibula forms a marked projection on the outer side of the ankle. 4211

811. The posterior part of a left foot, with the lower ends of the bones of the leg. The body of the astragalus has been vertically fractured and is separated into three or more pieces; a part appears also to have been detached from its posterior aspect. The outer of the fragments, which includes the head of the bone, has been completely dislocated outwards, after rupture of the interosseous ligament, and so twisted that its inferior articular surface looks equally downwards and outwards; the other fragments shown rest in their natural position on the upper surface of the os calcis. The head of the astragalus projects upon the dorsum of the foot, on the outer part of which it forms a smooth globular prominence about 3 cm. in front of the end of the fibula; the displaced fragment rests upon the cuboid bone to the outer side of the tendons of the extensor longus digitorum and over the extensor brevis muscle. In consequence of the displacement of the astragalus the foot is inverted, the inner border of the sole being considerably raised, and is adducted, the point of the inner malleolus lying in the hollow immediately behind the navicular, from which the astragalus has been displaced. The tendons of the peroneal muscles are tensely stretched; those on the inner side of the ankle are relaxed. 3680

The dislocation was compound, and was caused by a mass of earth falling on the patient whilst at work. The man sustained other injuries, and was dead when brought to the hospital.

812. Plaster cast of a left foot, with the lower part of the leg, showing a dislocation of the astragalus outwards, closely resembling the preceding. The foot is inverted and its inner border shortened, the arch of the sole being increased and the skin on the inner side thrown into vertical folds.

813. Plaster cast of a right foot, with the adjoining part of the leg, from a case in which the astragalus has been dislocated outwards almost in the same manner as in the preceding.

814. The anterior half of a right astragalus, including the anterior margin of its upper articular surface, which was removed some time after being dislocated forwards and outwards upon the dorsum of the foot.

The patient, a man 30 years of age, was admitted into the hospital in Sept. 1875. He was struck on the knees by some slabs of stone and fell sideways to the ground. When admitted the anterior fragment of the astragalus lay upon the cuboid, the posterior projected in front of the external malleolus, and was discoverable by deep pressure, an interval existing between the fractured portions; the foot was slightly inverted. Under chloroform the posterior fragment was reduced, and the leg placed on a Cline's splint; the reduction of the anterior fragment could only partially be effected. The integument over the head of the bone subsequently sloughed, and the portion of the astragalus shown was removed. The patient was discharged about two months after admission, with a sinus leading to a small piece of necrosed bone. In February 1876 he was readmitted, and a small sequestrum removed, after which he completely recovered with a very useful foot.

815. Plaster cast of the foot from which the preceding specimen was obtained, taken after the healing of the parts. Scarcely any deformity has resulted, the height of the posterior part of the foot remaining unaltered. A depressed scar on the front and outer aspect of the ankle marks the situation from which the anterior portion of the astragalus was removed.

## SERIES II.—DISEASES OF JOINTS.

## ACUTE INFLAMMATION WITH SUPPURATION.—ACUTE ARTHRITIS.

Acute suppurative arthritis is the result of the infection of a joint with any of the organisms causing acute suppuration. This infection may occur directly as the result of a wound or from a neighbouring focus of suppuration, or it may occur indirectly through the blood-stream. The conditions in which such an infection of a joint may occur are the following:—

1. Wounds of joints with septic infection (816).
2. Suppuration or ulceration of the surrounding soft parts (824, 827).
3. Acute suppuration in the epiphysis, or, more rarely, in the shaft of one of the bones entering into the formation of the joint (346).
4. Pyæmia. Under this heading may be included acute suppuration in joints occurring as a complication of certain acute infective diseases, such as typhoid fever (818), scarlet fever, acute pneumonia (977), and gonorrhœa.
5. Acute suppurative arthritis occasionally occurs without any obvious cause, or after a slight injury. This form is probably closely allied in its nature to acute infective suppuration of bone.

Acute suppuration occasionally occurs as a complication of various chronic joint-affections (819).

The changes occurring in a joint as the result of acute suppuration vary somewhat according to the cause, but in all essential respects are constant. The earliest change is usually an acute synovitis, the effusion rapidly becoming turbid or more or less distinctly purulent. In the later stages the following changes are to be noted:—

The tissues around the joint are swollen and infiltrated; the ligaments are swollen and softened, and, when fresh, redder than natural; the synovial membrane is represented by a layer of soft vascular granulation-tissue; the cartilages are usually destroyed at the points at which the opposite articular surfaces have been in contact; the remaining marginal parts are dull and lustreless, and but loosely adherent to the bone beneath (816). The bones where exposed by the destruction of the cartilages are at first bare and but little altered in appearance, but as the process of ulceration extends to them they become covered by a layer of soft granulation-tissue, which extends into the cancellous substance, producing a varying degree of rarefaction. At the points of greatest pressure, the inflamed bone may be worn away (821), and occasionally necrosis of the cancellous tissue may occur (827). If the disease continues after the subsidence of the acute stage, new osseous tissue is deposited on the surfaces of the bones in the neighbourhood of the joint, often in the form of irregular osteophytes (827).

Should recovery take place, complete restitution of function may follow, but more commonly a varying degree of fibrous ankylosis, or osseous ankylosis, occurs. Osseous ankylosis is particularly likely to follow in those cases in which the cartilages have been completely destroyed, and it results from direct ossification of the granulation-tissue which intervenes between the osseous surfaces.

**816.** A left elbow-joint, in which acute inflammation has been caused, apparently in consequence of fracture of the olecranon, the fracture having been most probably compound. The cartilage has disappeared from the edges of the articular surfaces of the several bones, and in part, also, from the detached fragment of the ulna;



that which remains is opaque and lustreless, and its edges are gradually thinned away to the surface of the bone, which, where exposed, is quite smooth and unaltered in appearance. The fractured surfaces are covered with soft fibrous tissue.

2131

The specimen illustrates the results of acute suppuration occurring in a joint after an injury followed by septic infection, and shows the articular cartilage to have been first removed from those parts of the bones which sustain the chief pressure, viz. the borders of the trochlear surface and sigmoid cavity and the central portions of the capitellum and head of the radius. The cartilage has been worn away by friction and by a process analogous to maceration in the decomposing pus in the joint, the whole process having been so acute that time has not elapsed for any changes to have taken place in the bone exposed.

817. The corresponding ends of a right femur and tibia with the connecting crucial ligaments, from a case in which acute inflammation of the knee-joint resulted from a fall which fractured the patella. The crucial ligaments are covered with a layer of inflammatory exudation. The cartilage upon the edges of the several articular surfaces has been destroyed by ulceration, which, as in the preceding specimen, has commenced on the free surface. The margins of the articular cartilage remaining are thinned towards the surface of the bone exposed, but the latter is unaltered in appearance.

818. An elbow-joint which has been laid open posteriorly by a transverse incision. The synovial membrane lining that part of the capsule which is attached to the posterior surface of the humerus above the trochlear surface is dark red in colour as the result of hæmorrhage into its substance, whilst its inner surface is roughened by inflammatory exudation. The adjacent part of the articular surface is stained, but in all other parts the joint appears to be normal.

8132

From a boy, aged 11, who died in the third week of typhoid fever. There was pus in both elbow-joints from which a pure culture of *Staphylococcus pyogenes aureus* was obtained. (Dr. Ringer's *Case-books*, 1898, Males, p. 513.)

819. A left knee-joint, in which acute inflammation was induced by the introduction of a seton, with a view to cause ankylosis in a case of "white swelling." Of the articular cartilage a few isolated areas with shelving edges alone remain; the layer of compact bone thus exposed is for the most part perforated by minute apertures, or has been completely removed by ulceration, the surface of the bone in the latter situations being covered with a layer of inflammatory exudation which has been in part accidentally detached. The anterior crucial ligament has been almost completely destroyed; its remains appear to have been covered with new tissue, by which it has apparently become adherent to the parts turned down in front; scarcely any remains of the semilunar cartilages are discernible. The synovial membrane on the subcutaneous portions of the condyles of the femur is converted into granulation-tissue.

378

Inflammation and suppuration within the joint and beneath the quadriceps extensor followed the introduction of the seton. The extent of the mischief in the thigh prevented amputation, and the patient died. This treatment of white swelling was adopted by Mr. Bell in another case previously to this, in which the limb had been condemned to amputation. "The seton was passed under the patella and through the joint with the view of inducing adhesion and ankylosis. It had the desired effect. Universal adhesion took place, and the man left the hospital with a stiff joint, but with an entire subsidence of the inflammation which had formerly worn out his constitution." He was able to walk ten miles a day. A year afterwards a sinus formed on one side of the knee, and the patient was attacked with erysipelas and died.

820. The upper end of a right ulna injected. The articular cartilage has been in great part destroyed, being absent especially from the borders of the articular surface, as though the destruction had commenced along this part; that which remains is in places very thin. Points of delicate granulation-tissue, the vascularity of which has been displayed by the injection, are irregularly scattered over the exposed bone; near its edges the cartilage is perforated by minute

circular apertures which are filled with similar vascular substance. The periosteum has been in part separated from the upper and posterior surfaces of the olecranon. 2683

From a patient who had acute suppuration of the elbow-joint.

821. The upper end of a left humerus. The lower half of the head, which is naturally in contact with the glenoid fossa when the arm is by the side, is flattened by ulceration, as if sawn off; the exposed cancellous tissue is more open than natural, its lamellæ being reduced to fine thread-like rods; the ulceration has, in several situations, extended to the layer of bone limiting the growing surface of the epiphysis. Over the portion of the articular surface remaining, except the border, the cartilage has been destroyed. A thin felt-like layer of new bone has been formed within the bicipital groove. The whole bone is lighter than natural. 3272

From a young subject in whom acute inflammation of the shoulder-joint had existed for seven days.

822. The phalanges of a finger, in the last two joints of which the articular surfaces have been destroyed by ulceration. The loss of substance is most marked in the distal ends of the first and second phalanges. The ulcerated articular surfaces are irregularly pitted, but the exposed cancellous tissue is less open than natural, and in places quite closed with new bone. The first two phalanges are unevenly ulcerated on their palmar aspect; the ulcerated surfaces are everywhere healed. 2964

The changes in the joints were probably the result of acute arthritis following suppuration in the sheath of the flexor tendon.

823. The first phalanx of a thumb, in which the distal extremity has been deeply and irregularly destroyed by ulceration. The surface of the bone in the neighbourhood is covered with recent osseous tissue. 2962

824. The phalanges of a finger. The articular parts of the bones forming the first interphalangeal joint have been extensively destroyed by ulceration. 2958

The disease of the joint followed a deep-seated whitlow.

825. A similar specimen. 2950

826. The phalanges of a finger. The dorsal half of the first phalanx is wanting, and the cancellous tissue of the second exposed around its base, in consequence of ulceration. 2945

827. A tibia and fibula of the right side together with the astragalus and os calcis. Extensive destruction of the articular surfaces of the ankle-joint has occurred, the articular layer of compact bone, except for a narrow strip across the highest part of the articular surface of the astragalus, being almost entirely absent. The exposed cancellous bone is very open in texture and in the astragalus a considerable portion of the cancellous tissue has undergone necrosis and lies loose in a cavity in the bone, its upper part including a portion of the articular surface.

The posterior astragalo-calcaneal joint shows changes similar to those present in the ankle, the articular surface of the astragalus being to a large extent involved by the sequestrum above mentioned. The other articular surfaces of the astragalus and os calcis are normal.

In addition to the changes present in the joints a considerable deposit of new bone has occurred around them. This is most abundant upon the posterior aspect of the lower extremities of the tibia and fibula, where it takes the form of foliated masses of finely porous bone. On the fibula the new osseous deposit extends upwards along the whole length of the shaft, 7018



From a man, aged 50, admitted into U. C. H. July 25, 1893, with a large ulcer on the outer side of the right leg and foot. Behind the external malleolus there was a sinus in which bare bone was felt. Subsequently diffuse cellulitis occurred and pus was evacuated from the ankle-joint and from numerous abscesses in the foot. On several occasions sugar was present in the urine, the largest amount being 504 grains in the day; the sp. gr. of the urine was 1016-1038; there was no albumen. On Sept. 27 amputation was performed in the upper third of the leg. The stump healed with slight suppuration; the patient was discharged Oct. 30. (Mr. Heath's *Case-books*, 1893, vol. ii. p. 158.)

828. A right patella, with portions of the tendinous structures attached to it. The marginal portion of the articular cartilage has been in part destroyed; that which remains is almost everywhere thinned and uneven. The central portion of the front of the bone is bare or covered with non-adherent sloughing tissue, as if superficially necrosed.

3363

From a man whose limb was amputated at the knee by Mr. Liston for a malignant tumour of the tibia, the patella being left in the anterior flap. Death occurred sixteen days after the operation from extensive abscesses and "irritative fever." For the tumour of the tibia see specimen 705.

829. A right patella which has been extensively destroyed as a result of necrosis. Of its outer half nothing remains except the cartilage, and this has been destroyed in its lower part by ulceration, a deep notch being present in its lower border and above this an irregular perforation separated from the notch by a bridge of undestroyed cartilage. The remaining inner half of the bone presents on its external aspect a nearly flat surface covered with granulation-tissue; and its anterior and posterior surfaces are also partly covered with a thin layer of granulation-tissue.

6872

From a boy, aged 12, admitted into U. C. H. on June 19, 1892. Pain in the right knee and swelling over the outer part of the patella began on June 2. An abscess burst on June 10, and on June 14 an "operation was performed under chloroform and it was said that the joint was exposed." On admission the right knee was distended with fluid, and there was a granulating surface and two sinuses over the outer part of the patella. On the day after admission fragments of carious bone were removed from the patella and turbid synovial fluid was withdrawn from the joint with an aspirator. On June 29 the patella was removed, and the synovial membrane of the knee, which was covered with bright red granulations, was freely cut away. On July 18 the patient was transferred to St. Mary's Hospital, where on July 30 the knee-joint was excised. (Mr. Heath's *Case-books*, 1892, vol. ii. p. 15.)

No evidence could be found microscopically of the presence of tubercle in the inflamed synovial membrane. It is probable that the disease of the patella and knee-joint was secondary to acute suppuration in the prepatellar bursa.

#### TUBERCULOUS DISEASE OF JOINTS.

Tuberculous disease of a joint may begin primarily in the synovial membrane, or as a secondary infection from a tuberculous deposit in the articular extremity of one of the bones entering into the formation of the joint.

In primary synovial disease the earliest sign is swelling of the fringes and a slight effusion of fluid into the joint. The synovial membrane becomes gradually converted into a layer of tuberculous granulation-tissue, which is often soft and pulpy, but may be dense and fibrous (830). This layer often exceeds a centimetre in thickness, and by the coalescence of the opposed surfaces the cavity of the joint may become in parts entirely obliterated (831, 832). Gradually the granulation-tissue spreads over the surface of the articular cartilages and becomes adherent to them (831). The cartilage itself is destroyed by the direct extension of the tuberculous tissue into its substance, partly from the margin and partly from the superficial surface, where pits or actual perforations are produced which by their gradual coalescence lead to extensive loss of substance (854). In rare instances considerable portions of the articular cartilage may be loosened from

the bone by the extension of the granulation-tissue beneath it, and fragments of necrosed cartilage may be more or less completely separated (834, 852). After the destruction of the cartilage the subjacent layer of compact bone soon disappears and the exposed cancellous tissue undergoes a rarefactive inflammation, the enlarged spaces being occupied by tuberculous tissue continuous with that which fills the cavity of the joint (837, 859). The invasion of the bone often spreads irregularly, so that deep pits filled with granulation-tissue are formed in the articular surface (870). While these changes are taking place within the joint the ligaments become swollen and softened, and gelatinous in appearance. Around the joint the inflammation extends to the periosteum and leads to a deposit of new bone, sometimes in considerable and irregular masses or osteophytes (837, 845). The compact tissue beneath the periosteum often presents signs of rarefactive inflammation, the Haversian canals being increased in size and the bone more spongy than natural. Ultimately the joint may, by these changes, be completely destroyed, nothing remaining to represent it but the carious articular ends of the bones embedded in a mass of soft tuberculous tissue. At a varying stage of the disease chronic suppuration is likely to occur as the result of the caseation and liquefaction of the tuberculous tissue occupying the cavity of the joint (880). The chronic abscess may occupy the whole of the joint-cavity, or may be limited to part of it, and, if unchecked, the abscess slowly perforates the capsule and superficial tissues, discharging on the surface and leaving sinuses leading into the joint (855).

In addition to the common form of synovial tuberculous disease above described, certain rarer varieties are sometimes met with. In some cases the disease results in a considerable effusion of fluid, which may contain melon-seed bodies and be unaccompanied by any marked thickening of the synovial membrane (1010). In other cases the synovial membrane is covered with dense, fibrous, nodular or polypoid masses.

When tuberculous disease of a joint results from a primary osseous deposit, the latter may be situated in the cancellous tissue beneath the cartilage (839), in the epiphysial line (853), or beneath the periosteum of an intra-articular portion of one of the bones (875). When once infection of the synovial membrane has occurred from such a deposit, the subsequent changes in the joint are in all essential respects similar to those occurring in primary synovial disease. In such cases sequestra are not uncommon (840); they are sometimes dense and wedge-shaped (842, 846). Should the tuberculous disease in the articular extremity run the course of a dry caries (p. 99), considerable disorganisation of the joint may occur without suppuration.

As a result of tuberculous disease of a joint complete or partial dislocation may take place under the influence of the tonic contraction of the muscles, in consequence of softening of the ligaments and destruction of the articular surfaces. If the joint recover, the tuberculous tissue is converted into fibrous tissue. Should this occur at an early stage of the disease and before the cartilages have been extensively destroyed, a varying degree of movement may be preserved; if, however, the cartilages have been extensively destroyed and the ligamentous structures involved, more or less complete fibrous ankylosis may result (1012 *et seq.*). Less commonly the disease results in osseous ankylosis (1027 *et seq.*). According to the frequency with which they are affected with tuberculous disease, the large joints may be arranged in the following order:—Hip, knee, elbow, ankle, wrist, shoulder, sacro-iliac articulation.

**830.** A left knee-joint, laid open to display the changes resulting from tuberculous disease of the synovial membrane. The synovial membrane is converted into a layer of soft-looking, buff-coloured granulation-tissue, having in some places a shreddy, in others a smooth surface. Around the edge of the patella, along the outer border of the condyles of the femur, and along the margin of its patellar



surface, the articular cartilage has been destroyed by ulceration ; in the situations last mentioned the ulcerated parts of the cartilage appear to have been overlain by the newly formed granulation-tissue. The cartilage covering the outer condyle of the femur has an uneven tuberculated surface. The crucial ligaments have been in part destroyed, and are thickly covered by granulation-tissue. Above the head of the fibula the dissection has displayed the cavity of a chronic abscess leading from the joint by the process of synovial membrane which invests the tendon of the popliteus ; over the upper end of the tibia an incision has been made into an extension of the abscess beneath the muscle itself.

370

The limb was removed by amputation.

- 831.** The left knee-joint of a girl, injected, and exhibiting a later stage of the changes shown in the preceding specimen. The synovial membrane is converted into a layer of firm-looking granulation-tissue, which, as shown by the injection, has become throughout very vascular, and appears to have united those parts of the synovial membrane which have lain in contact. The granulation-tissue has spread, also, over the articular cartilage, and the crucial ligaments are thickly surrounded by it ; the proper cavity of the joint appears to have been completely obliterated. By the forcible flexion of the joint the new tissue has been separated from the articular surface of the patella, and in part from the condyles of the femur ; in the cartilage over the inner condyle of the femur, thus exposed, is a shallow ulcerated pit, and on the inner border of the patella is a similar, though smaller, ulcer ; both the ulcers have most probably formed subsequently to the extension of the granulation-tissue from the synovial membrane over the articular cartilage. Over that portion of the inner condyle which is subcutaneous the integument has been completely destroyed by ulceration or sloughing, the granulation-tissue which fills the joint being here exposed. In the skin, a short distance above the outer condyle of the femur, there is a second ulcer, oval in form and about 1.5 cm. in length ; and besides this there are others situated on the posterior aspect of the knee. From all the apertures sinuses probably lead into the diseased joint. On the divided surface of the thigh, the granulation-tissue filling the upper part of the synovial cavity is seen in front of the femur.
- 832.** A right knee-joint, in which, as a result of tuberculous disease, granulation-tissue has been formed from the synovial membrane, and covers the several articular surfaces so as completely to obliterate the cavity of the joint. The cartilage over the outer condyle of the femur has almost wholly been destroyed by ulceration, that remaining is undermined, and its edges are thin and irregular ; the surface of the bone is covered with granulations by which this portion of the femur was probably adherent to the patella. The articular cartilage on the inner condyle is dull and soft-looking ; in its posterior part is a narrow annular ulcer, and around this the cartilage is superficially ulcerated.
- All the bones are considerably atrophied.
- 833.** A left knee-joint, from an adult, injected, and laid open to display its interior. The synovial membrane is converted into a layer of soft granulation-tissue, into which the injection has in part entered. The supra-patellar synovial pouch is incompletely obliterated ; on the outer side it is distended by an abscess, which opens by a short sinus on the surface. The articular cavity was probably quite filled with soft granulation-tissue, except where the bones were in contact and in the situation of the abscess mentioned. The articular cartilage is variously ulcerated upon the different bones, that covering the patellar surface of the femur being perforated with small circular apertures, whilst over the condylar surfaces of the tibia the bone has been exposed and is superficially ulcerated ; on the outer condylar surface the exposed bone is covered with very vascular granulations.

5023

Parts of the articular surface of the femur are also covered with a layer of granulation-tissue, most evident at the anterior part of the inner condyle. 2260

The limb was removed by amputation.

**834.** The left knee-joint of an adult. The synovial membrane is converted into soft granulation-tissue, and a layer of similar substance is spread over the cartilage of the outer condyle of the femur; along the lower border of the patellar surface, where this layer has been removed, the articular cartilage is deeply ulcerated, and in places undermined. From the inner condyle the articular cartilage has, in great part, been detached, the surface of the bone being covered with a layer of granulation tissue: the cartilage detached is thinner than natural, but its free surface is smooth and unaltered; on its deep aspect it is granular, and portions of soft tissue, similar to that covering the bone from which it has been separated, are in places adherent to it. Over the lower third of the patella, and around the margin of the patellar surface of the femur, the articular cartilage has been destroyed. The cartilage covering the upper end of the tibia is very thin, and along the hinder part of the inner condylar surface destroyed. The crucial ligaments are almost concealed by the new tissue surrounding them; at one spot the anterior ligament has been divided; its fibres are almost natural in appearance.

**835.** A left knee-joint, which has been the seat of tuberculous disease. The articular cartilage covering its several parts has been almost wholly destroyed, and upon the bone so exposed a thick layer of soft granulation-tissue is present, and has apparently united the different ulcerated bony surfaces and obliterated the cavity of the joint. At the back of the preparation the suprapatellar synovial pouch is readily recognizable; but its surfaces appear to have been adherent. 3352

From a boy, whose limb was amputated for the disease shown; he recovered after the operation.

**836.** The lower ends of the tibia and fibula, together with the astragalus of the left side. The portions of the bones entering into the formation of the ankle-joint are superficially rarefied, the cancellous tissue being uniformly exposed by the removal of the articular cartilage and the subjacent layer of compact osseous substance. The compact tissue of the lower end of the tibia also shows signs of rarefaction and inflammation, its Haversian canals being increased both in size and apparently in number, so as to render the osseous tissue less dense than natural; these appearances diminish in intensity as traced from the articular surface upwards. There is an oval perforation in the internal malleolus, the apex of which has also been destroyed. The surfaces beyond the articulation are, for the most part, thickly covered with osteophytes. 2926

It is most probable that the disease in this specimen commenced in the synovial membrane, and that the changes in the bones were of secondary occurrence. In the recent state the ulcerated surfaces were covered with granulation-tissue.

**837.** The lower part of a left humerus with the upper halves of the radius and ulna. As the result of chronic inflammation in the joint, the cartilage and subjacent layer of compact bone have been completely destroyed. The exposed cancellous tissue presents, as the result of rarefying inflammation, an unusually open texture, the osseous trabeculae being in part much thinned. The inner part of the olecranon is deeply excavated, possibly as the result of the separation of a necrosed portion of the cancellous tissue. New osseous tissue also covers the surfaces of the bones in the neighbourhood of the joint. The new bone has everywhere a compact exterior, and in parts is very dense or almost ivory-like, as though the disease in the joint had been of long duration. The lower part of the forearm was removed by amputation; the divided ends of the radius and ulna have been rounded by absorption, and in each of the bones the medullary canal is closed by a cap of compact osseous tissue. 3100

The disease of the elbow occurred subsequently to the amputation of the forearm. The patient was "scrofulous."



**838.** A vertical section of the right knee-joint of a child, the several parts of which have been forcibly separated after having become united by tough fibrous tissue, which had developed in the joint after destruction of the cartilage. In the head of the tibia is the cavity of a chronic abscess, measuring 1.5 cm. in its greatest diameter. The cavity lies partly in the diaphysis and partly in the epiphysis, the middle part of the epiphysal cartilage having been destroyed by the abscess. The inner surface of the cavity is lined by a thin, nearly smooth layer of granulation-tissue. From the upper part of the cavity a large track opens into the front of the knee-joint to the outer side of the middle line, and another extension of the outer part of the cavity passes backwards and opens above into the joint on the external condylar surface and below on the posterior aspect of the external tuberosity. On the posterior part of the inner condylar surface of the tibia is a deep rounded pit extending 1 cm. into the substance of the bone. In the posterior part of the internal condyle of the femur there is an abscess, smaller than that in the tibia and opening into the joint on the posterior aspect of the condyle. The cartilage on the head of the fibula is partly destroyed as the result of the extension of the disease into the superior tibio-fibular articulation.

3351

**839.** The corresponding ends of a right humerus and ulna. The lower part of the humerus is greatly enlarged and altered in texture by inflammation. Close above the articular surface an almost circular gap has been made through the lower end of the humerus by caries; and the bone, for nearly 1 cm. above and on either side of this aperture, is superficially ulcerated, and has apparently undergone subsequent necrosis. By the extension of the disease inferiorly the upper edge of the articular cartilage is undermined, but the cartilage itself is unaltered. Besides the circular aperture already noticed, there is a second perforation, about 3 mm. in diameter, leading through the inner part of the humerus a short distance above the internal condyle. On the ulna the articular cartilage has been destroyed for about the middle third of its extent, the denuded bone being also superficially carious.

3270

From a "scrofulous" child between five and six years of age. The limb was so small that it was amputated by Mr. Liston with a bistoury and bone-forceps; the end of the bone was split by the forceps.

**840.** The bones of a left foot, excepting the phalanges. All the articulations between the bones of the tarsus, with the exception of the calcaneo-cuboid and posterior division of the astragalo-calcaneal, have been affected in different degrees by tuberculous disease, commencing, probably, in the navicular bone, which is reduced to a slender ring by caries and necrosis of its central part. All the bones in connection with the synovial membrane pertaining to the articulations of the navicular show signs of superficial ulceration, as though secondarily affected in consequence of extension of the disease by the synovial membrane, the surfaces of the cuneiform bones which articulate with the navicular and those which articulate with each other and with the cuboid bone having been more or less extensively destroyed; the head of the astragalus is also superficially ulcerated. In most situations the ulcerated surfaces have healed, the cancellous tissue being closed by new bone; the inner and middle cuneiform bones are united by osseous substance, as also are the middle cuneiform and second metatarsal bones.

2926

**841.** The bones of a right foot, with the lower ends of the tibia and fibula. Except over the inner malleolus (on which the articular cartilage remains) and the borders of the upper surface of the astragalus, the articular parts of the bones forming the ankle-joint are superficially ulcerated. In the lower end of the tibia, in front, the line of the epiphysis is readily traceable on the outer side.

About 1 cm. from the articular surface of the tibia is a small excavated space in the lower end of the diaphysis, around which the cancellous tissue is in process of rarefactive inflammation, its spaces being widely open and its lamellæ much thinned; the affected portion is quite white, and contrasts strongly with the yellow fatty bone forming the rest of the tibia, an appearance which is due to its spaces having been filled with granulation-tissue in place of fat.

On the inferior articular surface of the tibia is a small excavation extending into the epiphysis directly towards the pit in the shaft above mentioned; and there is a similar excavation in the outer part of the tibia immediately above the epiphysis. Above and below the latter point, new bone has been deposited upon the fibula. New bone has also been formed in small amount on the posterior margin of the astragalus. All the bones, including the new osseous substance, are very greasy and atrophied. 2931

The patient recovered after removal of the parts by amputation. The origin of the disease in this specimen was probably a tuberculous deposit in the diaphysis of the tibia at that part indicated by the small depression in front; from this point the ulceration extended through the epiphysis to the cartilage of the articulation, which was subsequently perforated, the synovial membrane becoming secondarily affected, and ulceration of the articular cartilage occurring in other parts of the joint. The disease has extended laterally to the tibio-fibular articulation.

842. The bones forming a left knee-joint, in which, as the result of tuberculous disease, irregular destruction of all the articular surfaces has occurred, the exposed cancellous tissue being for the most part widely open. In the outer condyle of the femur a wedge-shaped piece of the bone has undergone necrosis, and contrasts by its white colour with the surrounding bone. The base of the wedge is formed by the compact articular layer, which is unaltered in appearance; the apex of the wedge is exposed in a deep pit on the outer surface of the condyle. The separation of the sequestrum is almost complete. A similar but somewhat larger sequestrum lies in the outer tuberosity of the tibia. In the inner tuberosity of the tibia are two other small irregular spongy sequestra, which are completely detached, but confined within spaces in the cancellous tissue. An irregular deposit of new bone has occurred around the margins of the articular surfaces.

From a man, 20 years of age, in whom the disease was of 6 years' duration. There was extensive suppuration within the joint. The patient recovered after amputation.

## TUBERCULOUS DISEASE OF SPECIAL JOINTS.

### TUBERCULOUS DISEASE OF THE ARTICULATIONS OF THE VERTEBRÆ.

These joints are most frequently diseased as a secondary result of caries affecting the bodies of the vertebræ. The disease may, however, occur primarily in the synovial membrane of the articulations.

843. An atlas, with the adjoining parts of the occipital bone and axis. On the right side, the atlas has become firmly united by bone to the condyle of the occipital bone after destruction of the parts which form the atlanto-occipital articulation. On the left side, the cartilage of the corresponding articulation has been in various degrees thinned and destroyed. The surface of the odontoid process, also, is everywhere unevenly ulcerated, the corresponding articular surface on the back of the atlas being obliterated and covered by fibrous tissue; the other articulations between the atlas and the axis likewise appear to have been affected.

4140



844. A sacrum, with the vertebræ of the lumbar region. The articulations between the fourth and fifth lumbar vertebræ, and between the latter and the sacrum, have, on the right side, been destroyed by caries of the articular surfaces, which, in the fifth lumbar vertebra, has led to the loss of the greater part of its upper articular process. The bodies of the four lower vertebræ on the same side are flattened and hollowed by ulceration; the diseased surfaces appear to be in process of healing, and are for the most part surrounded by ridges of new osseous substance; the intervertebral fibro-cartilages are unaffected. All the bones are light and atrophied. 4951

The erosion of the bodies of the vertebræ on the right side, and the deposition of new bone upon them, have probably resulted from the formation of an abscess in the substance of the psoas muscle in connection with the articular disease. The disease of the articulation between the last lumbar vertebra and the sacrum is in the same manner probably secondary to that of the articulation above.

#### TUBERCULOUS DISEASE OF THE SHOULDER-JOINT.

Tuberculous disease of the shoulder begins most commonly as a deposit in the upper extremity of the humerus (850), and not uncommonly may lead to extensive destruction without suppuration (dry caries). Sequestra may be present (846). In advanced cases the head of the scapula is often extensively destroyed (845). The abscesses resulting from tuberculous disease of the shoulder may extend to either border of the deltoid, or to the arm or axilla.

845. The upper part of a left humerus, with the scapula and outer end of the clavicle. As a result of caries the head of the humerus has been in great part destroyed; its remains, upon which the cancellous tissue is everywhere exposed to view and more than naturally open, present several shallow depressions; the adjoining portion of the bone is roughened with osteophytes; new bone has been formed in the bicipital groove. The head of the scapula has been almost completely destroyed, the disease having extended upwards on the root of the coracoid process, and backwards to the neck of the bone. New osseous tissue has been formed in large amount over the whole of the scapula, as well as upon the acromial end of the clavicle. 2931

846. The head of a humerus with the tuberosities, removed by operation. The natural shape of the head is completely lost, its greater part having been destroyed by caries, and its remains being pitted with deep depressions; near its upper part, behind and to the inner side of the small tuberosity, a pyramidal portion has become necrosed and lies completely detached, though not displaced, from the bone around; upon this necrosed portion the smooth articular surface of the head, divested of cartilage, is plainly recognisable. 2882

847. A right scapula, with the acromial portion of the clavicle, and the upper part of the humerus, from a case in which the upper extremity of the humerus, including its tuberosities, had been excised eleven years before death, the glenoid fossa being also gouged at the operation. A false joint has formed between the two new surfaces, each of which is coated with dense fibrous tissue. The parts are connected above and below by two firm ligamentous bands, the inner surface of which is smooth and polished, as in a natural capsule; as the humerus hangs vertically, the lower of these lies loosely folded.

The patient, a farm labourer, died eleven years after the operation, which was performed by Sir J. Erichsen. Mr. Shillitoe, of Hitchin, who presented the specimen, states that the arm was useful for all movements below the shoulder.

848. Plaster casts of the two shoulders from the same person, the head of the humerus having been excised on the right side. As compared with the left, the

right shoulder is smaller and less rounded, the acromion being unnaturally prominent, and the deltoid flattened on all its aspects in consequence of the removal of the upper end of the bone.

849. Plaster casts of the two shoulders of a man in whom the head of the left humerus had been excised. On the outer aspect from the acromion downwards the left shoulder is quite flat, the soft parts behind being thrown into a prominent fold. 4674

The patient, a man aged 42, had suffered from severe pains in the left shoulder-joint for about  $2\frac{1}{2}$  years before the operation, the pain having increased so much during the last six months as to have compelled him to desist from his occupation of pianoforte-maker. At the time of his admission the shoulder was swollen and excessively tender, and there was a sinus leading down to the head of the bone. The patient was operated upon in October 1861 by Sir John Erichsen, who removed the whole of the head of the humerus, which was in a carious state, and gouged away a very small portion of the lower part of the glenoid cavity, which was similarly diseased. In less than three months after the operation the man was able to do light work, and gradually gained strength in the arm, but abduction was very imperfect.

850. The remains of the upper extremity of a right humerus removed in the operation of excision of the shoulder-joint. The sawn surface, which is horizontal, presents two distinct caseous deposits, one in the great tuberosity, and one in the anterior part of the remains of the head of the bone. The surface left by the partial destruction of the head is for the most part irregular and covered with dense fibrous tissue, but at its inner part presents a small smooth convex surface, apparently part of the normal surface of the head, which is marked from the rest by a deep groove. 8254

From a girl aged 13, who was admitted into the Victoria Hospital for Children under the care of Mr. Raymond Johnson, Jan. 4, 1899. There had been stiffness of the right shoulder for 5 years. On admission the right arm was nearly fixed in an adducted position; the deltoid was wasted. Excision of the upper end of the humerus was performed; the caseous foci exposed in the sawn surface were scraped. The wound healed by first intention.

#### TUBERCULOUS DISEASE OF THE ELBOW-JOINT.

Tuberculous disease of the elbow may begin in the synovial membrane or in one of the bones. Of the latter, the olecranon process of the ulna is most commonly the seat of the primary deposit (853), but the lower extremity of the humerus and much less commonly the head of the radius may primarily be affected. The resulting abscesses appear most commonly in the first instance at the sides of the joint and often extend superficially considerable distances into the arm and forearm.

851. A wax model of a child's right arm, in which the elbow-joint had been destroyed by tuberculous disease. The elbow is uniformly swollen so as to measure about 8 cm. in diameter; the skin over the swelling is pale like that of the rest of the arm, but the subcutaneous veins are unnaturally evident. In the integument on the outer side there is a circular ulcerated opening, nearly 5 cm. in diameter, through which a mass of pulpy granulation-tissue projects; the edges of the opening are sharp and nearly flat. 2508

852. A right elbow-joint, injected. Almost the whole of the articular cartilage on the several bones has been destroyed. On the humerus a narrow line of the cartilage remains over the border of the articular surface, from which, however, it has been almost detached by ulceration of the bone beneath. The destruction of the cartilage has been hastened by the pressure or friction of the articular surfaces upon one another, as is shown by the amount of cartilage remaining on the lower part of the capitellum, which in the semiflexed position of the joint would have been uncovered except by the soft parts. The exposed bone



is covered with a layer of granulation-tissue, which has been imperfectly reddened by the injection. The surface of the bone around the joint is thickly beset with osteophytes. Similar changes have occurred in the bones of the forearm. The lower end of the humerus, a short distance above the capitellum, is perforated by a small, irregular opening leading into a large excavation in the bone. 384

During life extensive abscesses surrounded the joint. The patient was "scrofulous."

853. A sagittal section of the right elbow of a child. The cartilaginous epiphysis of the olecranon is separated from the rest of the bone by a caseous deposit, and the upper end of the ulna and the lower end of the shaft of the humerus are enlarged and infiltrated with a similar substance. The cavity of the elbow-joint is distended, and contains two large caseous deposits, one of which fills the front of the joint and the other occupies the olecranon fossa of the humerus. Continuous with these two deposits is a thin membrane-like layer of granulation-tissue, which extends completely across the joint between the articular surfaces of the humerus and ulna. The articular surface of the humerus appears to be normal, but on the ulna the cartilage has been partly destroyed. 6457

From a female child aged 14 months. Swelling of the left thumb had been noticed for about 3 months, and of the right elbow for 14 days. On admission, the child was wasted; the cervical glands were enlarged; the first phalanx of the left thumb was enlarged and there was an abscess on its inner side; there was fulness about the right elbow. The abscess in the thumb was opened and the carious bone scraped. Death occurred a month after admission, from increasing emaciation. There were scattered tubercles in both lungs and in the liver, and the bronchial and mediastinal glands were caseous. (Surg. Reg. Rep. 1889, p. 111, No. 862.)

854. The anterior half of the lower end of the right humerus of a child, in which the articular cartilage has been in part destroyed. The cartilage is perforated with numerous minute round apertures, some of which have united to form larger and less regular ones. Some of the larger apertures are occupied by soft granulation-tissue. Around the margin of the articular surface are seen remains of the tuberculous synovial membrane. 2274

855. A left elbow-joint, with the surrounding soft parts, the bones being exposed on the inner side by dissection. The articular cartilage and superficial layer of the subjacent bone have been destroyed, and the lower end of the humerus perforated, by caries, which has extended also directly upwards towards the medullary canal. From the extensive abscess resulting, two sinuses, marked by pieces of coloured glass, lead through the overlying soft parts to the surface; and there is a third opening on the front of the elbow, which, it is probable, also communicated with the diseased joint, whilst a fourth sinus passes directly outwards and opens behind the outer condyle. On the outer aspect of the elbow considerable portions of the integument have been destroyed by ulceration. 385

The patient was a young man in whom the disease of the elbow came on after an attack of erysipelas of the arm; a year and a half afterwards he submitted to amputation; the bones at that time distinctly grated when moved upon each other; extensive abscesses surrounded and communicated with the joint. "A fleecy tissue, loaded with pus," was removed from between the surfaces of the bones in exposing them.

856. A right elbow-joint, with the surrounding soft parts, injected. The olecranon has been almost completely destroyed by caries, the cartilage covering the corresponding posterior portion of the trochlear surface of the humerus being also destroyed, and the surfaces of the bones so exposed being covered with vascular granulation-tissue. The remaining portion of the joint appears to be quite healthy. A short sinus leads from the posterior part of the joint almost directly backwards through the integument; from the surface around the external opening of the

sinus there projects a flattened, circular, papillomatous growth about 6 cm. in diameter. The joint has been fixed in the semiflexed position. 2258

*Microscopic Structure.*—The papillomatous growth around the sinus is of a simple character and the deeper structures contain tuberculous nodules.

857. The bones entering into the formation of the left elbow-joint of a young subject. On each of the three bones the cartilage and articular layer of compact bone have in parts been destroyed and the subjacent cancellous tissue exposed. The general shape of the articular surfaces is unaltered. New bone mostly in the form of pointed osteophytes has been thrown out on the bones, the articular extremities of which are enlarged. 2925

The limb was amputated, and the patient recovered.

858. The bones of a right elbow-joint, considerable portions of the articular parts of which have been destroyed by caries, the shaft of the humerus being also perforated in the situation of the olecranon fossa. The coronoid process of the ulna is completely wanting; and in the great sigmoid cavity a large irregular piece of the bone has undergone necrosis, and is surrounded by a deeply excavated groove; the lower part of the sequestrum is almost completely isolated from the surrounding parts. In the outer border of the groove noticed the cancellous spaces are small, and their laminae coated with delicate new bone; the spaces of the sequestrum are widely open, and their lamellae unaltered in appearance. On the inner aspect of the ulna the disease has spread downwards a considerable distance beyond the articulation, and in one situation appears to have extended through the new bone which has been formed in the neighbourhood of the disease. The head of the radius is almost wholly wanting. 3121

859. The corresponding extremities of a left humerus and of the bones of the forearm, removed by operation. The articular cartilage has everywhere disappeared, and the surfaces of the several bones are covered with a thick irregular layer of tuberculous granulation-tissue. 3347

The patient was an elderly lady under the care of Mr. Liston. The operation was followed by complete recovery.

860. The upper articular parts of a radius and ulna, with the lower part of the humerus, removed in excision of the elbow-joint. The several articular surfaces have been in varying degrees superficially destroyed, chiefly where they are naturally in contact in the semiflexed position of the joint; at certain points the disease has caused small circular apertures in the limiting compact layer, in other parts this layer is completely wanting.

861. The articular portions of the bones entering into the formation of a left elbow-joint which were removed by excision. The olecranon has been completely separated by the disease, the line of separation passing obliquely through the middle of the great sigmoid cavity, and the surfaces of the fragments being for the most part healed. The articular cartilage covering the ulna and the trochlear surface of the humerus has been in part destroyed, but that of the radio-humeral part of the articulation has escaped. Remains of the tuberculous synovial membrane are seen around the edges of the articular surfaces. 7349

862. The portions of the bones of a right elbow-joint removed by excision. The cancellous tissue beneath their articular surfaces is everywhere exposed by ulceration, which, in certain situations, has extended more deeply than in others; the surfaces adjoining the articulation are thickly beset with long, thorny, and laminar osteophytes. 3297

The patient was under the care of Mr. Liston.



- 863.** A sagittal section of a right elbow, the articular extremities of the bones having been previously excised. The bones are held together by dense fibrous tissue, that which connects the radius to the humerus having a thickness of 1.5 cm. A large irregular mass of bone projects from the front of the extremity of the ulna and assists in forming the new joint. A considerable deposit of new bone is also present on the posterior aspect of the humerus. Posteriorly the fibrous expansion of the tendon of the triceps is firmly attached to the back of the ulna. The section of the humerus and radius shows that the divided ends of the bones are closed by a thin compact layer. The radius is in a position of semi-pronation.

5888

From a man aged 45, who was admitted into U. C. H., Feb. 1, 1883, for disease of the left hip-joint with sinuses. A large abscess over the joint containing offensive pus was opened and drained. Death occurred on the 23rd day from pyæmia. The left hip was disorganized and both knees contained pus. The elbow had been excised some time previously; there was good movement in the new joint. (Mr. Heath's *Case-books*, 1883, vol. ii. p. 107.)

- 864.** The lower half of a right humerus, with the bones of the forearm, in which portions of the articular parts forming the elbow-joint were removed by excision. The section of the humerus has not been carried sufficiently high to remove the whole of the articular surface, and both the condyles remain, as does also the base of the coronoid process of the ulna; a very thin slice appears to have been removed from the head of the radius. The sawn surfaces of the bones are, for the most part, healed, but around them, especially on the ulna and internal condyle, the bone is very open in texture and the trabeculae are thinned as if rarefactive inflammation were still advancing in it. The neighbouring parts of the bones are irregularly covered with osteophytes.

3651

The limb was removed by amputation seven months after the excision of the elbow-joint.

About twelve weeks before admission to the hospital the elbow became inflamed and swollen, and an inflammatory swelling appeared also over the hip. Both swellings were opened; that over the elbow-joint discharged freely when the man presented himself at the hospital, and a piece of bone was exposed in the opening. The joint was excised, and about seven months afterwards Mr. Liston amputated the arm in consequence of the existence of several sinuses which did not heal, and the detection of dead bone.

- 865.** A vertical section of a left elbow, together with some of the surrounding muscles, in which tuberculous disease recurred after excision of the joint. The section shows that the inner part of the new articulation is formed between the divided surface of the lower end of the humerus and the anterior surface of the upper end of the shaft of the ulna. The cavity of the new joint is lined with soft granulation-tissue which covers also the surfaces of the bones. The new joint is closed behind by the expansion of the triceps tendon which is adherent to the end of the ulna. In the front part of the cavity of the new joint two pieces of glass indicate the position of sinuses leading inwards; the lower of these corresponded to an opening in the integument, and the upper leads into an abscess-cavity measuring 3 cm. in its greatest diameter.

7448

From a patient who was the subject of pulmonary phthisis. Excision of the elbow was performed at the Brompton Hospital. Amputation was afterwards performed at the middle of the arm on account of return of the disease. (See Godlee, *Lecture on Bone and Joint changes in connection with Thoracic Disease*. 'Brit. Med. Journ.,' July 11 & 18, 1896.)

#### TUBERCULOUS DISEASE OF THE WRIST-JOINT AND ARTICULATIONS OF THE HAND.

Tuberculous disease of the wrist is often associated with disease of the carpus and metacarpus, so that it is often impossible to determine the exact starting-point (866). In some instances the disease appears to begin in the synovial membrane, or as a deposit in the lower extremity of the radius. The joint-affection is sometimes

secondary to disease in some of the surrounding tendon-sheaths. Abscesses are most common on the dorsal aspect of the joint. The joints of the fingers are rarely affected by tuberculous disease.

- 866.** The lower ends of a left radius and ulna, with the carpal and inner four metacarpal bones. The articular surfaces of the several bones, with the exception of the metacarpal surface of the trapezium and the corresponding surfaces of the unciform and inner two metacarpal bones, have been in various degrees destroyed by caries, and of many of the bones considerable portions are wanting; the parts remaining are very light, their cancellous spaces larger than natural, and their surfaces irregularly pitted. The lower end of the radius is deeply excavated, and a portion of its cancellous tissue has undergone necrosis; the lower extremity of the ulna has been entirely destroyed. Upon the surfaces of some of the bones pointed outgrowths of osseous substance have been formed. The unciform and os magnum are ankylosed by bone, as also are the several metacarpal bones. 2928

From a man, 45 years of age, in whom the disease had been of long duration. He recovered after amputation.

All the bones are affected, chiefly on the surfaces which are in connection with the synovial membrane of the wrist-joint. The thin inner border of the scaphoid is completely destroyed, the articular cavity of the wrist being thus continuous with that between the carpal bones. There is nothing to show definitely in what structures the disease began; but if it commenced in any single bone its extension has clearly been by means of the synovial membrane, as in the trapezium and unciform bones only those surfaces which enter into the large synovial cavity of the wrist are affected.

- 867.** The lower ends of a left radius and ulna, together with the bones of the carpus and metacarpus. The second and third metacarpal bones are extensively hollowed out by ulceration which, in each, has destroyed considerable parts of the proximal extremity. In the third the disease has extended throughout the whole length of the interior of the bone, the compact wall of which, in the lowest 2 cm. of its dorsal surface, is completely wanting. The remaining surfaces of the second and third metacarpals are rendered irregular by pointed osteophytes, and the remains of their proximal extremities are ankylosed by bone to the os magnum and trapezoid, which have also been extensively destroyed and are ankylosed to each other. All the remaining carpal bones are rendered irregular by the formation of new bone on their non-articular surfaces, whilst their articular surfaces, with the exception of those on the trapezium and unciform for the corresponding metacarpal bones, are superficially ulcerated. The scaphoid and trapezium are united by bone. The articular surface of the radius entering into the formation of the wrist-joint also shows evidence of superficial ulceration, and on the adjacent parts of both bones an irregular growth of osteophytes has occurred, these being most marked on the posterior surface of the radius along the ridges separating the grooves for the tendons. The articular surfaces of the inferior radio-ulnar articulation are healthy. 2927

From a man 25 years of age, whose health was much impaired by the disease which was of long duration. Amputation was successfully performed.

- 868.** The lower ends of a right radius and ulna, in which the articular parts have, in great measure, been destroyed by caries. A layer of porous osseous substance of irregular thickness has been formed upon the bones for about their lower 5 cm. The diseased surfaces show no signs of healing. 2933

The patient was an old woman who had long suffered from disease of the wrist. She recovered after amputation.

- 869.** The bones of a right carpus, with the inner four metacarpal bones. From the apposed surfaces of the former the articular cartilage has been wholly destroyed, the superficial parts of most of the bones being also affected. Those surfaces of the scaphoid and lunar which articulate with the radius present



no appearance of having been diseased; the articulation of the pisiform bone and the metacarpal surface of the trapezium are also unaffected. All the carpo-metacarpal articulations, with the exception of the first, appear to have been involved in the disease. Upon several of the bones long, closely-set, pointed osteophytes have been formed.

2932

From a man 33 years of age, who was long affected with the disease, and in whom the parts were removed by amputation. He recovered.

It is observable that only those surfaces of bone which are in connection with the common synovial cavity of the carpal bones are affected, a circumstance which favours the idea that the disease was of synovial origin.

#### TUBERCULOUS DISEASE OF THE SACRO-ILIAC ARTICULATION.

Tuberculous disease of the sacro-iliac joint is rare; it appears usually to begin as a deposit in the sacrum or ilium, the articulation itself being involved secondarily. Sequestra may be present in one or both of the joint-surfaces (871). An abscess may form on either aspect of the joint; if it forms anteriorly within the pelvis the pus may find its way outwards through the great sacro-sciatic foramen, or it may extend downwards beside the rectum, or lastly it may extend forwards into the iliac fossa (870) or into the sheath of the psoas (871).

870. A left hip-bone, with the corresponding half of the sacrum and the lower three lumbar vertebræ. The surfaces of the sacro-iliac articulation are everywhere destroyed, the bone being irregularly excavated in shallow circular fossæ. Similar changes have occurred below and behind the articular surface, both on the ilium and sacrum, so that the normal outline of the articulation is almost obliterated. The exposed trabeculæ of the diseased surface of the sacrum are much thinner, and the bone rougher and more porous than on the diseased surface of the ilium. On the sacral surface a deep pit has been left by the separation of a necrosed portion of the cancellous tissue. Scarcely a trace of new bone has been formed on the surfaces adjoining. In the anterior and upper part of the iliac fossa is an extensive layer of somewhat dense new bone, formed probably in consequence of the irritation caused by an iliac abscess arising from the diseased joint. There is also an irregular deposit of new bone on the front of the body of the third lumbar vertebra.

4277

From a man under the care of Sir John Erichsen.

871. A right hip-bone with the corresponding half of the sacrum and the upper part of the femur. The surfaces of the sacro-iliac joint are everywhere roughened and irregularly pitted by ulceration. In the lower part of the auricular surface of the sacrum there is an irregularly oval opening, measuring 2 cm. by 1 cm., and leading into a considerable cavity in the bone, which communicates with the right upper anterior sacral foramen. The cavity contains a loose spongy sequestrum. Below this opening the right border of the sacrum is rarefied. Thin, and in parts irregular, deposits of new osseous tissue, resulting from the presence of a chronic abscess, are seen chiefly on the upper and posterior parts of the iliac fossa, on the ilio-pectineal eminence, and on the posterior surface of the femur, around and below the small trochanter.

7483

From a man, aged 20, who ricked his right leg 12 months before his admission into U. C. H. Four months after the accident weakness in the back was complained of, and soon afterwards an abscess formed and was opened. On admission there was an ulcer above and internal to the right posterior superior iliac spine, from which a sinus passed for 6 cm., but no bare bone was felt. The right hip-joint was slightly flexed. The sinus was enlarged and scraped. Subsequently the discharge from the sinus became brown in colour and faecal in odour, and a large faecal abscess was opened on the inner side of the thigh. Death occurred 2 months after admission. At the *post-mortem* examination the abscess was found to occupy the whole

length of the right psoas muscle, extending also into the iliac fossa and over the brim of the pelvis beneath the obturator internus muscle. The cæcum lay in front of the abscess cavity, but no communication was found between the abscess and the intestine. In the thigh the abscess reached as low as the popliteal space. There was a very large cavity in the right lung, involving nearly the whole of the upper and middle lobes. The left lung was normal. The spleen, kidneys, and thyroid were lardaceous, but the liver, although enlarged, did not give the lardaceous reaction. (Surg. Reg. Rep. 1895, p. 116, No. 2218.)

872. A right hip-bone, in which the auricular surface has been completely destroyed by caries, which in places has extended into the substance of the bone up to its outer compact wall. The trabeculæ of the exposed cancellous bone are in parts thin and sharp as though the disease were advancing; in other parts the trabeculæ are thick and the spaces partly closed as the result of healing. On the outer surface of the ilium, in the part corresponding to the diseased articulation, a layer of very dense new bone has been formed. 1369

873. The bones of a pelvis. On the right side the surfaces of the sacro-iliac articulation are superficially carious and present an unnaturally open texture, but no extensive loss of substance. A deposit of new bone has occurred around the articular surface on the ilium and also on the corresponding part of the outer surface of the bone. New bone also has been extensively formed in an irregularly porous layer on the front of the sacrum; the deposit is most extensive on the right ala and on the front of the first segment, but it can be traced over the greater part of the anterior surface and extends into the anterior sacral foramina, especially the upper two on the right side. The symphysis pubis also shows evidences of having been chronically inflamed; the articular surfaces of the pubic bones are superficially carious and an irregular deposit of new bone has occurred around them, most abundantly on the inferior surface of the body of the left pubis. 6745

From a man aged 37, admitted into U. C. H. July 3, 1891. In June 1890 an abscess in the left groin was opened in the London Hospital and in six weeks had nearly closed. A second abscess then formed in the same groin and was opened but did not heal. In Jan. 1891 there was pain in the right hip, and in June swelling of the right buttock. On admission, there was a painful swelling over the position of the right sacro-iliac joint, and great pain was caused by pressing together the crests of the hip-bones. There were two sinuses in the left groin, through one of which bare bone was felt on the pubis. The abscess over the sacro-iliac joint was aspirated, and the pelvis fixed with plaster of Paris. Temperature varied from 100° to 102°·6. Patient left the hospital July 30, but in September was readmitted to a Medical Ward and died of pulmonary phthisis on Sept. 30. Connected with the posterior part of the right sacro-iliac joint were three distinct abscesses, two of which were deeply placed beneath the multifidus spinæ, whilst the third extended on to the back of the ilium. The left sacro-iliac joint gaped somewhat when the anterior ligament was divided, and its interior was redder than natural. The body of the fifth lumbar vertebra was diseased and an abscess extended from it on to the right ala of the sacrum. The symphysis pubis gaped widely and a large calcareous sequestrum had incompletely separated from the left pubis.

(Mr. Heath's *Case-books*, 1891, vol. i. p. 255.)

### TUBERCULOUS DISEASE OF THE HIP-JOINT.

Tuberculous disease of the hip-joint may commence in the synovial membrane or in the femur or acetabulum. Most commonly, especially in young subjects, the primary deposit is in the neck of the femur, outside the epiphysial line (875); less commonly the deposit is in the epiphysial line (874) or in the cancellous tissue of the head. Primary disease of the acetabulum is much less common; it usually occurs in the floor of the cavity. Primary disease of the synovial membrane appears to be much less common than the secondary invasion of the joint from a primary deposit in one or another of the above situations.

Among the changes occurring in the upper extremity of the femur are the



following :— Erosion and excavation of the neck, especially in the lower and anterior part (881); destruction of the articular cartilage and superficial caries of the head (880); separation of sequestra (890); extensive destruction of the head (878); and, in rare instances, complete separation of the head. The disease may invade the great trochanter or even extend a considerable distance within the shaft of the bone.

In the acetabulum the following changes may occur :—Destruction of the articular cartilage and superficial caries (882); separation of sequestra (881); excavation and perforation of the floor (879, 885); destruction of the brim, especially at the upper and posterior part of the cavity, with resulting enlargement of the latter (878, 888).

As a result of the loss of substance in the head of the femur and in the brim of the acetabulum, the upper extremity of the femur may be gradually displaced upwards and backwards on to the external surface of the ilium by the action of the muscles (884). This displacement of the femur is attended with gradual extension of the hollow of the acetabulum in the same direction, that part of the cavity from which the femur has been withdrawn showing more or less evidence of a healing process (889).

The abscesses resulting from tuberculous disease of the hip may be situated outside or inside the pelvis. Of the extra-pelvic abscesses one of the most common is that which, after perforating the posterior part of the capsule, is directed forwards by the smaller gluteal muscles, and is first detected as a fulness in the outer part of Scarpa's triangle, from whence it often passes downwards and somewhat backwards (880). Abscesses may also form in the buttock, in the neighbourhood of the great trochanter, or at the upper part of the inner aspect of the thigh. An intra-pelvic abscess usually results from disease of the acetabulum; the abscess is situated between the obturator internus and the bone (880) and may extend upwards into the iliac fossa, pointing above Poupart's ligament, or downwards beside the rectum, sometimes communicating with the bowel. Occasionally a hip-joint abscess enters the sheath of the psoas muscle.

Abscesses closely simulating those resulting from disease of the hip-joint may be caused by disease of the femur or hip-bone not involving the joint itself.

**874.** A section through the parts entering into the formation of the right hip-joint of a young subject. In the substance of the neck of the femur and encroaching on the epiphysial line is a small cavity in the bone which is filled with a soft deposit, by which a small portion of the centre of the cartilage is almost completely surrounded. The inner surface of the capsule of the joint and the round ligament are covered with a thin layer of a soft brownish-yellow exudation, which extends up to the margins of the articular surfaces and in parts slightly encroaches upon them. The bone forming the floor of the non-articular part of the acetabulum is softer and presents a yellower colour than the surrounding bone, and on its inner aspect a thin layer of new osseous tissue has been formed on its surface. 5911

From a child who died of tuberculous meningitis.

**875.** The right hip-joint of a young subject, the head and neck of the femur having been divided vertically. In the under surface of the neck of the femur there is a deep excavation, which is partly filled with a mass of granulation-tissue. In the posterior half of the divided head and neck the cavity is separated from the epiphysial line by a layer of sclerosed bone, which contrasts by its more yellow colour with the surrounding cancellous tissue; in the anterior half of the neck the cavity reaches the epiphysial line, and its upper part was probably occupied by the anterior, separated part of the sclerosed portion of bone, which is, doubtless, an incompletely detached sequestrum. The epiphysial cartilage is in part destroyed, and the disease is commencing to invade the cancellous tissue of the head. The articular surfaces of the bones are normal, but the round ligament and the part of

the capsule remaining in the specimen are covered with a soft, friable, brownish-yellow deposit, which also fills the cotyloid notch and is creeping over the anterior part of the articular cartilage of the acetabulum. The capsule itself is thickened.

7502

From a male child, aged 6 years, who died of tuberculous meningitis. There had been pain in the right hip for some months, which became worse after a fall a month before admission. The child was poorly nourished and the right hip-joint was flexed, abducted, and rotated out. There was thickening and tenderness about the trochanter. Temp.  $101^{\circ}$ – $103^{\circ}$ . Weight extension was applied and after 19 days a double Thomas's splint. The child then became restless, screamed, and vomited. Five days later convulsions occurred: two days after this the child became unconscious, with dilated pupils; fits recurred and the patient died. A few tubercles were present on the surface of the lungs and in the Sylvian fissure on each side of the brain. (Surg. Reg. Rep. 1896, p. 104, No. 2829.)

**876.** A wax model of the left hip-joint of a child and of a longitudinal section of the upper end of the femur. The ligamentum teres is represented as intensely congested from inflammation, but nothing otherwise abnormal is shown in the joint. On the inner and posterior aspect of the shaft of the femur a layer of new bone, about 5 mm. in thickness, except above, where it is thinner, has been formed; the new bone corresponded in position with an abscess.

2789

**877.** A section of the femur from which the preceding model was taken. The layer of new bone is extremely light and porous, and surrounds the inner and posterior surfaces of the diaphysis as far as its upper extremity; posteriorly the new osseous tissue is raised in prominent overhanging processes.

3295

The exact nature of this specimen is uncertain, but it is probable that the conditions present resulted from a tuberculous focus in the upper end of the femur.

**878.** The right hip-joint of a young subject. The head of the femur has been greatly flattened above and behind, and the acetabulum considerably increased in extent by caries. The destruction of the head of the femur is most marked at that part where it has been in contact with the acetabulum; its lower surface is still rounded in form and covered in parts with articular cartilage. The cancellous tissue is in places exposed by the breaking down or accidental removal of the granulation-tissue which covered it. In the deepest part of the acetabulum osseous tissue is entirely wanting, the floor being formed by the indurated soft parts within the pelvis. No trace of the ligamentum teres remains. At the back of the joint there is an oval opening in the capsule about 2 cm. in length, the edges of which are covered with smooth, soft granulation-tissue continuous with that which lines the interior of the joint. The limb was shortened by fully 5 cm.

487

**879.** The upper end of the right femur of a child, with the corresponding portion of the hip-bone. The head of the femur is considerably reduced in size, and the acetabulum presents a long linear aperture, as a result of caries; the aperture across the acetabulum is interrupted, near its anterior end, by a narrow line of bone. The upper part of the margin of the cavity has been completely destroyed, and the head of the femur partially dislocated upwards. New bone is in process of formation in the anterior and lower parts of the acetabulum and on the outer surface of the ilium, above the situation in which the head of the bone has lain.

365

During life the thigh was drawn up on the abdomen. Extensive abscesses surrounded the joint. One abscess, which formed within the pelvis, pointed in the groin, and communicated with the others through the opening in the acetabulum.

**880.** The right hip-bone and femur of a child, with the adjoining soft parts. As a result of disease of the hip-joint the bottom of the acetabulum has been perforated; a piece of blue glass has been passed from the joint through the perforation into the cavity of an abscess which has formed within the pelvis



beneath the greatly thickened obturator fascia. The substance of the obturator internus has been almost entirely destroyed. The abscess is confined within the pelvis, and, as is usual in such cases, has not extended beside the tendon of the obturator internus through the sciatic notch. There is a second and smaller abscess opening into the front of the joint to the outer side of the pectineus, and immediately beneath the situation of the ilio-psoas muscle; whilst a third abscess, overlying the vastus externus and occupying the greater part of the length of the thigh, leads upwards between the tensor vaginae femoris and rectus muscles, and backwards for a short distance beneath the gluteus minimus, but the communication between the upper end of the abscess and the hip-joint is not recognisable. The thigh is rotated inwards and adducted, and is flexed almost to a right angle. In preparing the specimen the head of the femur has been dislocated towards the outer surface of the ilium; the articular cartilage is destroyed only over its central part, where the head of the femur has been in contact with the acetabulum; but its margins are ulcerating, and ulceration is progressing also in the exposed cancellous tissue of the head. 3849

881. The upper end of a left femur, with the corresponding part of the hip-bone, the latter made extremely light by inflammation of its substance and increased in size by the formation of new bone upon it; over the ilium the new osseous tissue has a laminated construction, conformable with the natural surface of the subjacent bone. The whole of the cancellous tissue of the head of the femur, and part of that of the acetabulum, is exposed by caries which in the femur has led to the formation of a large shallow excavation on the front and lower part of its neck. The neck of the femur and the great trochanter are enlarged by the formation of new bone: both the new bone and the old are extremely light and porous. The acetabulum appears to have been perforated at its deepest part; the bone surrounding the perforation on the inner aspect is superficially ulcerated; in the middle of the ulcerating part a sequestrum is in process of separation. 3375

882. The bones of the right hip-joint of a woman twenty-five years of age. The articular portion of the acetabulum is superficially carious, the most marked destruction of the osseous substance being at its upper part; a short way below the centre of the acetabulum the bone is smooth and polished on its surface. The head of the femur is flattened on its upper aspect by ulceration, the loss of substance corresponding in position with the area of greatest friction or pressure. In parts the cancellous spaces are more or less perfectly closed by dense osseous tissue, which has been worn smooth and presents the ordinary appearances of eburnation—those parts of the articular surfaces which are pressed together by the action of the muscles exhibiting the appearances of active disease, whilst in other parts signs of repair are discernible. On its inferior margin the head of the femur is perforated with small, irregular apertures. New bone has been deposited on the inner surface of the hip-bone opposite the acetabulum, and in small quantity also around the acetabulum and along the anterior intertrochanteric line of the femur. 4257

883. The corresponding portions of a right femur and hip-bone. The cancellous tissue of the articular surfaces is everywhere exposed, and the head of the femur grooved by caries. The acetabulum is surrounded with closely-set laminar outgrowths; on the femur similar growths have been formed, chiefly in the situation of the anterior intertrochanteric line. A small portion of the articular cartilage remains on the lower part of the head of the femur. 5167

884. A right hip-bone, with the upper end of the femur. The head of the femur has been extensively destroyed, and presents an irregularly flattened articular surface directed inwards and upwards. Inferiorly the disease extends

beyond the neck of the bone, whilst superiorly a portion of the natural articular surface, 12 mm. in width, remains covered with cartilage and apparently unaltered. On the flattened surface described the cancellous spaces have been filled in with dense new bone, so as to give it an almost smooth exterior; with the aid of a lens the original spicula of bone constructing the cancellous tissue are clearly recognizable, the spaces of the tissue being filled with excessively dense ivory-like osseous substance. Over the upper half of the surface the cancellous spaces are open and the surface is less regular; but the osseous lamellæ are of natural thickness, and break down with difficulty under pressure. On the upper part of the acetabulum a flattened surface of corresponding appearance has been formed after considerable destruction of its margin. The femur has undergone considerable displacement upwards, the two surfaces described accurately articulating. Over the lower part of the acetabulum, as upon the upper border of the head of the femur, the articular cartilage is intact. An abundance of firm, yet brittle, porous new bone has been formed on the ilium, above and behind the margin of the acetabulum, in elongated masses radiately arranged around the cavity; a similar formation of osseous tissue has taken place on the anterior intertrochanteric line and posterior part of the femur. The neck of the femur is deeply pitted with irregular depressions on its upper aspect; and the inflammation appears, also, to have extended around the anterior margin of the acetabulum into the iliac fossa, the lower half of which is incrustated with an uneven layer of new bone, partly porous and partly compact. The acetabulum is somewhat deepened, and its surface irregular and perforated in several places by minute apertures; internally the bone corresponding in situation with the acetabulum is covered with a thin layer of new osseous tissue, the density of which shows it to have been formed previously to that above the margin of the acetabulum. 3998

The specimen was obtained from the dissecting-room. From the absence of history the nature of the disease is doubtful, but it was probably tuberculous.

885. The left hip-bone, with the upper part of the femur of a young subject, showing changes, the result of advanced destructive disease of the hip-joint. The disease has affected chiefly the acetabulum, which has been deepened, and so increased in area as to measure about 7 cm. in diameter; at its bottom is an almost circular opening nearly 5 cm. in diameter. A thin layer of new bone has been formed over the upper posterior part of the iliac fossa. The head of the femur, flattened and greatly reduced in size by caries, presents a deep oval pit on its upper aspect; new bone has been formed on the front of the femur as far as the intertrochanteric line. The diseased parts show scarcely anywhere signs of healing.

1278

886. The left hip-bone of a young subject, in which extensive changes have occurred in consequence of disease of the hip-joint. The natural form of the acetabulum is no longer recognisable, but in its place a deeply-excavated cavity, in several places leading through the entire thickness of the bone, has been formed: the cavity extends from the cotyloid notch upwards for nearly 8 cm., and measures 5 cm. from side to side, reaching backwards almost to the great sciatic notch. At its highest part the margins of the space are widely overhanging and entirely of new formation, yet of sufficient age to have become compact in texture and like the natural tissue of the bone. It is not improbable that the upper end of the femur lay within the highest part of the enlarged space. The largest of the perforations is above the brim of the pelvis, the others below; the edges of the former are smoothly healed, and a layer of new osseous substance has been deposited upon the inner surface of the bone in its neighbourhood. The whole bone is light and atrophied.

3095

887. A left hip-bone, with the upper end of the femur. As a result of tuberculous



disease, the head and neck of the femur have been completely destroyed; the loss of substance also involves the upper and front part of the great trochanter, the outer surface of which also is deeply pitted. The acetabulum appears to have escaped almost entirely. The only articulation remaining between the femur and the hip-bone is formed by the apposition of the inner surface of the great trochanter with the upper and posterior part of the margin of the acetabulum, the two surfaces being held together by fibrous tissue. A very slight deposit of new bone has been formed around the acetabulum. The hip is flexed and the femur strongly adducted.

205

The patient, a young woman, died of lumbar abscess and disease of the vertebræ. She had recovered from the disease of the hip-joint.

- 888.** A left hip-bone, with the upper part of the femur. The head and the greater part of the neck of the femur have been destroyed, the smooth surface resulting being covered apparently with a layer of dried fibrous tissue. The lower half of the acetabulum is little altered, but the upper part is considerably increased in area and flattened, as the result of partial destruction of its margin and the formation of dense new bone in its cavity. New bone has been formed on the ilium above and in front of the acetabulum, and the femur and hip-bone are held together by the thickened remains of the capsule.

3074

- 889.** A left hip-bone, with the upper end of the femur and part of the sacrum. The intracapsular portion of the femur and the marginal part of the acetabulum have been destroyed. The femur has been displaced slightly upwards, and the thigh flexed to a right angle and adducted, the remains of the small trochanter corresponding with a depressed area near the ilio-pectineal eminence. The diseased surfaces bear no evidence of having commenced to heal where they have lain in contact; but the lower part of the acetabulum, from which the femur has been displaced, is completely healed. In the iliac fossa there are some excavations and patches of new bone, probably the results of an iliac abscess. All parts of the hip-bone are thin and slender, especially the rami of the ischium and pubis. The ilium is unusually flat, so that the hollow of the iliac fossa is but little marked. There is a sixth segment in the sacrum.

3702

The specimen was obtained from a dissection subject, an emaciated woman 19 years of age. The left leg was undeveloped; the thigh was flexed and adducted so as to cross that of the opposite side. The soft parts were ulcerated to the bone.

- 890.** An elongated portion of the head of a femur, including about a third of its surface, with a portion of the subjacent cancellous tissue.

3289

The sequestrum was extracted by Mr. Liston from an abscess of the hip-joint.

- 891.** The upper part of a left femur, with the corresponding portion of the hip-bone, the head of the femur having been removed by operation. Before the parts were displaced by dissection the sawn surface of the base of the neck of the femur was united to the ilium, above the acetabulum, by a thick mass of dense fibrous tissue, the limb being strongly flexed and adducted. The lowest part of the neck of the femur, increased in size by a deposit of new bone, forms a prominent projection, which, when the parts are placed in their natural positions, rests beneath the upper border of the acetabulum, and serves to limit further displacement of the femur upwards. Connected with the bony prominence on the femur is a dense fibrous band, which stretches across the acetabulum and appears to represent the remains of the capsule, which has been torn away from the lower part of the brim of the acetabulum, where the bone is bare and in part destroyed. In the floor of the acetabulum is an irregularly circular opening, measuring 3 cm. in diameter; its edges are thin and smooth. On the inner aspect of the hip-bone around this opening, and also in the anterior part of the iliac fossa, the periosteum is covered with a soft, smooth, yellowish layer, probably of granulation-tissue, lining an abscess-cavity.

6940

From a man, aged 34, admitted into U. C. H., under the care of Mr. Heath, Oct. 10, 1892. For 15 years he had had pains about the left hip, and for 7 years had walked on crutches and been unable to work. Two months before admission an abscess opened spontaneously. On admission the left hip was fixed in a position of flexion, adduction, and internal rotation. There was muscular wasting of the limb, with  $\frac{3}{4}$  inch shortening; there was also thickening about the great trochanter, and a sinus behind it. On Oct. 12 excision was performed through a posterior incision, the neck of the femur being divided with an Adams's saw. The cartilage covering the head of the femur was destroyed, and there was a large cavity in the bone. On Oct. 21 an abscess containing foul pus was opened on the front of the thigh; profuse discharge continued; the temperature remained irregular, and death from erysipelas occurred on Jan. 13, 1893. (Mr. Heath's *Case-books*, 1893, vol. i. p. 490.)

**892.** A vertical section of the left hip-joint of a young subject, the head of the femur having been removed by operation some time before death. The sawn surface of the base of the neck of the femur has healed and the cancellous tissue is closed by a layer of compact bone, covering which is a thick layer of dense fibrous tissue. In the acetabulum the disease is still advancing; its floor is irregularly excavated and at one spot completely perforated. Above the perforation the bone forming the upper part of the floor of the acetabulum is bare and evidently in process of separation as a sequestrum. Between the femur and the acetabulum is an irregular abscess-cavity, from which a sinus, marked by a piece of glass rod, leads backwards into the buttock, and at a higher level is continued outwards through the base of a large ulcer in the integument covering the highest part of the great trochanter. 6102

From a boy, aged 16, admitted into U. C. H., Oct. 2, 1884. Symptoms of disease of the left hip followed a fall 4 months previously. Extension was applied, and on Dec. 10 an abscess under the tensor vaginae femoris opened; it did not seem to communicate with the hip-joint. On Jan. 14, 1885, the head of the femur was excised; the joint itself was found to be involved. Death occurred on Feb. 25, and was preceded by headache, vomiting, and convulsions. There was tuberculous meningitis, and caseous deposits were present in the apices of both lungs. (Surg. Reg. Rep. 1885, p. 84, No. 2291.)

## TUBERCULOUS DISEASE OF THE KNEE-JOINT.

Tuberculous disease of the knee-joint is very common, both as a primary affection of the synovial membrane and as a secondary infection of the joint from a tuberculous deposit in one of the bones. Osseous deposits are most commonly situated in the epiphysis of the femur or tibia (895), and may result in the separation of sequestra (895, 896). Primary disease of the patella is rare.

The abscesses occurring in tuberculous disease of the knee are most commonly situated on the anterior aspect of the joint, above the patella, or on either side of the ligamentum patellæ. The abscesses often have no direct communication with the joint, but not uncommonly the articular cavity may itself be distended into a large chronic abscess.

The less common forms of tuberculous synovial disease, such as those resulting in abundant effusion of fluid into the joint or in nodular fibroid thickenings of the synovial membrane, have been chiefly observed in the knee-joint.

In chronic disease of the knee the joint tends to assume a position of flexion, and at the same time the head of the tibia is liable to become displaced backwards, and the leg rotated outwards. In this contracted position the joint may become fixed by fibrous or bony ankylosis (1044 *et seq.*).

**893.** The upper end of the left tibia, with the patella, from a young woman whose knee was affected with tuberculous disease. The articular cartilage of the patella has, except for a narrow line around its margin, been destroyed, and the subjacent bone, covered with a thin layer of granulation-tissue (in great part wanting), is superficially carious. The edges of the cartilage are thin and undermined. On



both articular surfaces of the tibia somewhat similar changes have occurred; over the outer the articular cartilage is wholly wanting in its anterior half, the surface of the bone exposed being considerably depressed, in part apparently as a result of pressure from the condyle of the femur; on the inner condylar surface a small part of the inner and central portion of the cartilage, greatly thinned by ulceration, alone remains. A ridge of slender, prominent osteophytes has been formed upon the margin of the patella, and others surround the border of the head of the tibia. The synovial membrane is thickened, and is inseparably blended with the thickened tissues lying upon it. 1791

From the manner in which the posterior part of the outer articular surface of the tibia has escaped, it is evident that the joint was in the position usual in such cases, the tibia being rotated outwards and displaced somewhat backwards into the ham. The disease is most extensive in those parts of the articular surfaces of the bones which have been in contact.

894. The bones entering into the formation of a right knee-joint, with their connecting ligaments. The articular cartilage of the condyles of the femur has been almost completely destroyed. The bone thus exposed is in some parts smooth and unaltered, in others its thin compact wall has been destroyed. On the upper surface of the tibia similar changes have occurred. The articular cartilage of the patella is thin and uneven from ulceration, which has completely destroyed a narrow line of its marginal portion so as to lay bare the articular portion of the bone. The anterior crucial ligament has in great part been destroyed; its remains project in loose shreddy tufts within the joint. 373

From a man, 36 years of age, in whom the disease commenced after a fall on the knee, two years before admission to the hospital. When admitted the knee was much swollen and inflamed. On account of the general health of the patient, who was suffering from disease of the lungs, amputation was not resorted to. The disease in the knee increased, and the purulent expectoration became more copious; extensive sinuses surrounded the joint communicating with its cavity.

895. The bones forming a right knee-joint. Ulceration has almost uniformly exposed the cancellous tissue beneath the articular surfaces; in the head of the tibia the disease has in places extended more deeply, and anteriorly, at the bottom of a deep pit, has spread around a sequestrum of the cancellous tissue. The bones, in the neighbourhood of the joint, are covered with lowly-projecting osteophytes; on the patella these form a series of parallel ridges arranged in a longitudinal direction, at the bottom of the furrows between which lie the apertures of numerous large vessels. The tibio-fibular articulation is unaffected. 3290

896. The bones forming a left knee-joint, in which, as a result of long-continued tuberculous disease, the articular parts have been made uneven, the external condyle of the femur being in great measure destroyed. Between the condyles of the femur in front, and in the anterior part of the inner condyle, are two deep pits, in which it is probable that sequestra at some time lay. On the inner condylar surface of the tibia a portion of the cancellous tissue, including its limiting compact layer, has been almost completely detached after necrosis. On the posterior and inner part of the outer articular surface, also, a smaller portion of necrosed cancellous tissue has been almost completely separated, and beneath the outer border of the same surface is a deep smooth-walled canal extending from the articulation to the outer aspect of the tuberosity, in which it is probable that a small sequestrum once lay. The cancellous tissue, even around the sequestra, is in process of healing, its spaces being mostly closed by new bone, which before maceration was covered with fibroid tissue or granulations. Little osseous substance has been formed on the surfaces of the bones in the neighbourhood of the joint. 2920

The patient recovered after amputation of the limb.

897. The bones of a right knee-joint, all the articular surfaces of which have been extensively destroyed, the articulation between the tibia and fibula also being involved. The cartilage and subjacent layer of compact bone have disappeared from all parts of the knee-joint, and the exposed cancellous tissue is irregularly excavated, in part probably as the result of the separation of sequestra. In the femur the loss of substance has affected chiefly the external condyle, the natural prominence of which is replaced by a hollow. The spine of the tibia is undermined, and on the inner half of the internal condylar surface of the tibia is a shallow depression corresponding with the posterior rounded portion of the internal condyle of the femur. A variable amount of new bone has been thrown out around the remains of the articular surfaces, especially on the patella. 2922

The parts were removed by amputation and the patient recovered.

898. The bones entering into the formation of a right knee-joint. The cancellous tissue beneath their articular surfaces is almost evenly exposed by destruction of the compact layer. Above the inner condyle of the femur is an oval depression about 4 cm. in length, and in each of the condylar surfaces of the tibia are large irregular pits. The diseased surfaces appear for the most part to have been in process of healing. The ends of the two bones and the front of the patella are thickly covered with a layer of bony plates, ridges, and nodules. 3283

899. The corresponding articular parts of a right femur and tibia, removed by excision of the knee-joint. Considerable portions of the cartilage of each have been destroyed, the bone so exposed being superficially rarefied. The portions of the cartilage remaining have abrupt minutely irregular or jagged edges, which are in some situations undermined, and thin and shelving on their deep surface, showing the disease to have extended here between the cartilage and the bone, the apposed parts of which have been superficially destroyed. The destruction of the cartilage has apparently commenced at the margin. 4117

The patient was a strumous-looking lad, 14 years of age, who fell on the knee whilst running, six years before admission to the hospital; the skin over the knee was not wounded in the injury. About a week after the fall the joint commenced to swell, and continued to increase in size till December 1854. At this time an opening was made into the inner and lower part. During the seven months after the opening was made the wound discharged pus, but afterwards healed. On admission another incision was made into the joint, after which a purulent discharge occurred. The circumference of the diseased knee taken over the patella was 15 inches, that of the sound knee being 12½ inches. The joint was excised by Sir John Erichsen, and the patient recovered.

900. The corresponding articular parts of a left femur and tibia, removed by excision of the knee-joint. The articular portion of the femur is deeply and irregularly pitted. In the articular part of the tibia a large portion of the outer condylar surface has been destroyed, the section being perforated at this spot by a large aperture; near this perforation the section has passed through the base of a more shallow excavation; as seen from the deep aspect the situation of the latter is marked by an irregular patch of white fibroid tissue. The inner condylar surface of the tibia is half encircled by a narrow undermining groove, which terminates, at either extremity, in a deep excavation. A small portion of cartilage remains on the articular surface of each of the bones, which are somewhat atrophied and fatty from disuse. 4273

From a young woman, under the care of Sir John Erichsen, who had suffered for some years from disease of the knee-joint. For several weeks after the operation the patient did well, but the wound was attacked with erysipelas, and she died.

901. A sagittal section of the corresponding parts of the left femur and tibia of a young subject, the articular parts of which together with the patella had been removed by operation some time before death, on account of tuberculous disease of the joint. In the femur the epiphysis has been entirely removed, but in the tibia the greater part of the section was within the substance of the epiphysis, so that the epiphysial cartilage, in its anterior part, remains. No union has occurred



between the divided surfaces, which are covered with a layer of granulation-tissue. Part of the skin which has been left over the front of the knee is irregularly ulcerated and two small sinuses lead into interval between the bones.

902. A sagittal section of the right knee-joint of a young subject, in which arthrectomy had been performed for tuberculous disease. No part of the articular extremities of the femur and tibia has been removed, but the bones are firmly held together in the extended position, after slight displacement backwards of the head of the tibia, by a dense layer of white fibrous tissue, which almost completely obliterates the original cavity of the joint. The fibrous tissue by which the femur and tibia are connected is very intimately adherent to their contiguous surfaces, which had been denuded of cartilage and rendered irregular by the disease. The patella is fixed over its central part to the front of the femur by fibrous tissue, but above and below the adherent portion a small unobliterated part of the joint remains between the two bones. From the lower of these cavities a sinus extends outwards and forwards and corresponded to a small opening in the skin. The bones themselves, except in their articular surfaces, present a normal appearance and the epiphysial lines are unaltered. 6685

From a boy, aged 13, who died of pulmonary tuberculosis in 1891 (Surg. Reg. Rep. 1891, p. 169, No. 2675). Arthrectomy of the right knee had been performed by Mr. Barker in 1889 (Surg. Reg. Rep. 1889, p. 130, No. 1003).

903. The corresponding articular portions of a left femur and tibia, together with the patella, removed in the operation of excision of the knee-joint. The articular surfaces of the femur and tibia have been rendered very uneven, partly by the formation of irregular excavations, and partly by the presence of irregular osteophytes, particularly around their margins. The surfaces thus altered are in some parts covered with tough fibrous tissue, in others with friable granulation-tissue. In the intercondylar notch of the femur a considerable deposit of new bone has been formed, the surface of which is very dense and in parts smoothly polished. On the sawn surface of the tibia is seen a section through a caseous deposit in the bone which corresponded with the upper part of a large excavation in the tibia. The articular surface of the patella is rendered cup-shaped by a deposit of new bone around its margin and is covered with coarse bands of fibrous tissue. 8102

From a man, aged 45, in whom the left knee had been somewhat enlarged since a fracture of the lower end of the femur, which was followed by an abscess, 30 years previously. In Oct. 1897 the knee became painful and more swollen. The lower part of the femur was enlarged and there was a fluctuating swelling on the inner side of the patella. There were two scars on the outer side of the thigh, from one of which a sinus led into the popliteal space. There was considerable movement in the knee-joint. Excision of the knee was performed with good result on Aug. 11, 1898.

904. A right knee-joint in which arthrectomy had been performed for tuberculous disease 16 years before death. The joint has been opened by a transverse incision dividing the ligamentum patellæ. The bones have been forcibly separated, leaving a thin layer of torn fibrous tissue covering the articular surfaces. The latter are altered in size, shape, and direction; they are small, and the condylar surfaces of the tibia are directed laterally as well as upwards. In the inner half of the joint the corresponding articular surfaces are flattened; the outer condyle retains its convex outline and the corresponding surface of the tibia presents a prominent lip anteriorly. The intercondylar notch is filled with dense fibrous tissue. The patella is much increased in vertical measurement by the formation of new bone below it; it has been forcibly separated from a prominent rounded mass of new bone thrown out on the front of the femur. 7199

Arthrectomy of the right knee was performed by Mr. Beck when the patient was about 7 years old. The patient died from phthisis and acute pneumonia at the age of 23. (Dr. Poore's *Case-books*, Males, 1893, vol. i. p. 137.)

905. Parts of a right femur and tibia the articular extremities of which had been removed in the operation of excision of the knee-joint for tuberculous disease. No union has occurred between the sawn surfaces of the two bones, which are covered with a thin layer of granulation-tissue. Over the posterior part of the cut surface of the tibia this layer is thicker than elsewhere and forms a group of small rounded masses. On the front of the lower part of the shaft of the femur are seen the remains of a large abscess-cavity in the form of an irregular granulating surface. On the outer side this surface is continuous, by a narrow track above the external condyle, with another irregular abscess-cavity on the posterior aspect of the femur. 7447

From a man who was the subject of pulmonary phthisis. The bones did not unite after the excision, and death resulted from the lung-disease. (*See* Godlee, Clinical Lecture on Bone and Joint Changes in connection with Thoracic Disease. Brit. Med. Journ., July 11 & 18, 1896.)

906. Part of the diseased synovial membrane removed in the operation of arthrectomy for tuberculous disease of the knee-joint. The membrane is greatly thickened and its inner surface rendered very irregular chiefly by an overgrowth of the synovial fringes, which present small tongue-like processes and larger lobulated masses of dense fibrous structure. 6852

From a woman aged 23, whose right knee had been enlarged since a fall at the age of 16. Recently the joint had been painful. On admission the knee was greatly enlarged as the result chiefly of swelling of the synovial membrane. The joint could be flexed to a right angle. The joint was opened by a horseshoe-shaped incision and the diseased synovial membrane removed; the cartilage was eroded at its margin. Patient left the hospital 3 weeks after the operation with the limb in plaster.

Examined microscopically the diseased synovial membrane consists of three layers, a superficial layer of granular substance, a middle layer of delicate connective tissue containing a few tubercle-systems, and an outer layer of dense fibrous tissue with a few caseous foci. (Mr. Barker & Mr. Godlee's *Case-books*, 1892, vol. ii. p. 106.)

#### TUBERCULOUS DISEASE OF THE ANKLE-JOINT AND ARTICULATIONS OF THE FOOT.

Tuberculous disease of the ankle-joint appears not uncommonly to begin as a primary disease of the synovial membrane (908), but it is often secondary to disease of the bones, especially the astragalus. The most common situations of the abscesses are the lateral aspects of the joint, in front of or behind the malleoli. Tuberculous disease of the tarsal articulations is usually associated with more or less extensive bone disease, so that it is often impossible to determine the situation of the primary focus. Of the joints of the toes, the metatarso-phalangeal articulation of the great toe is the only one which is at all commonly affected.

907. A wax model of a right foot and lower third of the leg removed by amputation, apparently by the modified circular method. There is swelling in the region of the ankle-joint and on each side there is an extensive ulcer of the integument. In the middle of the ulcer on the inner aspect of the ankle a necrosed portion of the internal malleolus is exposed. Behind and above this ulcer there is a third ulcer about 3 cm. in length, of regular oval form, and placed transversely to the axis of the limb. The larger ulcers have a sharp sinuous edge, and nowhere show any signs of healing. In the situation of the necrosed internal malleolus a sinus led into the ankle-joint. 2858

908. A right ankle-joint, laid open from the front, the astragalus being turned downwards. Its interior is covered with a soft, coarsely granular layer of new tissue, which has for the most part a rough shreddy surface, as though the parts had been forcibly separated after their union by granulation-tissue. The articular cartilage appears to have been entirely destroyed. The surfaces of the astragalus



which articulate with the os calcis and navicular are coated with a thin membranous layer, but the articular cartilage appears quite healthy. 3357

The thin adhesions noticed are examples of those which form in healthy joints after prolonged and absolute rest.

909. A wax model of a right foot, and adjoining part of the leg, from a patient suffering from tuberculous disease of the tarsal bones. The inner side of the foot, from the ankle to the base of the first metatarsal bone, is considerably swollen. The integument over the swelling is mottled with pink, and the subcutaneous veins are more evident than natural. In the centre of this swelling is an ulcer, with raised, well-defined, and sinuous edges; the floor of the ulcer is formed by pale granulations. About 5 cm. behind this is a second smaller ulcer, concealed beneath a dry brown scab, and there is a third immediately in front of the malleolus on the outer side of the ankle. 4175

From a man 21 years of age. The disease was supposed to have begun eleven months before admission into the hospital, at which time the foot was injured by a fall; soon after the injury inflammatory symptoms set in. Syme's amputation was successfully performed. The astragalus, on examination, was found to be softened and covered with granulation-tissue, the articular cartilage having been entirely destroyed. The anterior part of the os calcis and the posterior part of the cuboid bone were also diseased. The navicular was totally disorganized.

910. A wax model of the left foot, and adjoining part of the leg, from a patient suffering from tuberculous disease of the tarsal bones, illustrating the form of swelling which characterizes this disease. There is an extensive swelling of the soft parts corresponding with the tarsus, except that on the dorsum it reaches as far as the roots of the toes; the swelling is more marked on the inner than on the outer side of the foot. On the inner side, over the head of the astragalus, the skin is congested, and perforated in three situations by small ulcerated apertures which led probably to sinuses arising from the diseased bone. In the integument of the dorsum of the foot there are two slightly larger ulcers about 7 cm. apart, the lower situated over the base of the fourth metatarsal bone, and there is an ulcer also behind each malleolus. All the larger ulcers have cleanly defined, slightly swollen, congested edges, and their floors are formed by pale granulations. 4173

The patient, a man 20 years of age, was admitted to the hospital in March 1839. As the disease increased, although the man's health improved, Mr. Quain removed the foot by Syme's operation. On dissection the astragalus, os calcis, navicular, and cuboid were found diseased; the surrounding integument was infiltrated. The patient left the hospital quite well a month after the operation.

911. A vertical section of a child's right foot, injected, in which some of the smaller tarsal bones, and the bases of the second and third metatarsal bones, have been partially destroyed by tuberculous disease. The articulations between the astragalus and the navicular, and the astragalus and os calcis, are unaffected, the disease being confined to the articular surfaces concerned in the formation of the single synovial cavity between the navicular and the cuneiform bones, the external cuneiform and the cuboid, and the two outer cuneiform and the second and third metatarsal bones. The anterior part of the navicular has been extensively destroyed. The disease has commenced either in the synovial membrane or in one of the cuneiform bones, spreading subsequently to the synovial membrane. The diseased articular surfaces are imperfectly covered with a thin layer of granulation-tissue, into which the injection has in places passed. All the bones are rarefied. 2366

912. A left foot removed by amputation for tuberculous disease of the transverse tarsal articulation. The latter has been exposed by a free transverse incision. The cartilage has been entirely destroyed on all the four articular surfaces, which are rendered slightly irregular and are covered with a thin layer of soft granulation-tissue. The ankle-joint and the sawn surface of the os calcis present a healthy appearance. 6253

913. The phalanges of a toe, the corresponding articular parts of the first and second being destroyed by superficial caries; the exposed cancellous tissue is everywhere light and its spaces widely open. On the surfaces of each of the phalanges is a nodulated accumulation of very porous newly-formed bone. 2953
914. The phalanges of a great toe, with the distal extremity of the first metatarsal bone, and one of the sesamoid bones. The articular surfaces of the metatarsophalangeal joint have been in part destroyed by caries, which has extended beyond the articulation on one side, and deeply within the head of the metatarsal bone. In the ungual phalanx a fracture, passing obliquely across the base and through the articular surface, has united with scarcely a trace of displacement. 2959

#### SYPHILITIC DISEASE OF JOINTS.

In the later stages of syphilis certain chronic changes may occur in the joints, which in some respects resemble those caused by tuberculous disease. The most common condition is thickening of the synovial membrane, which may present itself in a diffuse form or as a circumscribed gumma. Extensive disorganization of a joint may be associated with syphilitic caries of the bones entering into its formation (561). In children the subjects of congenital syphilis a chronic form of synovitis, occasionally affecting both knee-joints, is sometimes met with.

#### RHEUMATOID ARTHRITIS.

This disease assumes two distinct forms, the one affecting many of the joints and attacking the large and small articulations at the same time, the other attacking only one or two of the larger joints, usually the hip and knee. The former occurs in young or middle-aged subjects, the latter only in advanced life. The pathological changes in the two forms are practically identical. The disease when affecting a single joint is far more common in the hip or knee than in any of the other articulations.

The pathological changes observable to the naked eye are the following:—The cartilages towards their central parts lose their natural smooth and shining surface and assume a velvety appearance (963). This is due to a splitting of the matrix in a vertical direction accompanied by fibrillation of its substance (962). The effect of this roughening of the cartilages is that, by the friction of the two surfaces one upon the other, they become gradually worn away, and at last the bone beneath is exposed (962, 963). The friction between the two osseous surfaces causes a certain degree of irritation, as a consequence of which new bone of excessive density is formed, filling up the exposed cancellous spaces. This new bone may by friction be worn down smooth and polished like ivory, a condition known as “eburnation” (969, 974). More often the friction of the opposed surfaces leads to extensive destruction of both, the two becoming worn into mutually adapted grooves, hollows, and ridges (972). The dense layer of bone on the surface is often perforated by numerous small apertures (939, 971), which are seen in the fresh state to be filled with a fibro-cartilaginous substance. Whilst these alterations are occurring in the articular surfaces, changes also take place at their margins. By an overgrowth of the cartilage a rounded border or lip is formed around the edge of the articular surface (918, 964). This lip increases in size and becomes more or less nodular (967, 977); and ossification occurs in the cartilaginous outgrowths with the formation of irregularly rounded masses of new bone (941). In their shape these bony outgrowths differ entirely from the jagged and pointed osteophytes formed around inflamed joints (862). The nodular masses of new bone may reach such a size as completely to fix the joint, thus simulating true ankylosis (928, 958). Occasionally



isolated cartilaginous plates, subsequently undergoing ossification, may form in the subsynovial tissue. The synovial membrane also presents marked changes. At first there may be a slight excess of fluid, slightly turbid from the admixture of the detritus of the cartilages. In the later stages the membrane is opaque and thickened, and its fringes from an early period in the disease may be hypertrophied so as occasionally to give it a villous appearance (965, 967, 976).

The soft crackling in the early stages is due to the velvety state of the cartilages and the villous and thickened condition of the synovial membrane. The grating of the later stages is from the friction of the exposed bony surfaces upon each other. The enlargement of the joint is due chiefly to the bony outgrowths, which also tend to limit the movements of the articulation. In part also the enlargement is due to the thickening of the synovial membrane. The distortions of the smaller joints are due to the bony outgrowths. The shortening of the limb that sometimes occurs when the hip is affected is due to the gradual destruction of the head of the femur (944). At the same time the shape of the neck of the bone may alter from interstitial absorption, so that it becomes set more at a right angle to the shaft than natural. As the ligaments are not softened true dislocation never occurs in the larger joints; but in the smaller joints the articular surfaces may be almost separated one from the other by the pressure of the bony outgrowths.

Interarticular ligaments and fibro-cartilages, such as the round ligament of the hip, the tendon of the biceps, and the semilunar cartilages of the knee, are often completely destroyed, apparently being worn away by the friction of the diseased articular surfaces. The disease itself does not lead to suppuration, but the latter may occasionally occur in a joint affected by rheumatoid arthritis from causes such as may induce suppuration in a healthy joint (977).

**915.** An atlas, in which the surface for the odontoid process is increased both in extent and depth, partly by absorption, partly by the formation of a nodulated ridge of new bone around it. The articular surface is in places extremely dense, smooth, and polished; in others it is perforated by deep irregular pits, some of which lead through the entire thickness of the new bone formed above it. The remaining articular surfaces are normal.

**916.** Two cervical vertebræ, in which all the articular surfaces exhibit changes due to rheumatoid arthritis. In one vertebra both the articular surfaces on the left side are greatly increased in extent by irregular formations of new bone around them, the extensions of their surfaces being smoothly polished, and in parts deeply pitted by spaces spreading far into the bone, so as to give the surface a worm-eaten appearance. A considerable amount of the osseous tissue which forms the articular processes has been worn away by friction, the upper and lower articular surfaces being considerably approximated. Around the articular surfaces of the right side bony outgrowths have been formed in less amount; in a few spots the new bone is eburnated; similar changes have occurred in connection with the lower posterior margin of the body of the same vertebra. The other vertebra presents similar appearances; the articular surfaces of the right side are, however, more extensively affected than those of the left. The lower surface of the body is much extended by outgrowths of new bone; it is everywhere firm and of open cancellated texture; the intervertebral disk was most probably destroyed.

**917.** The upper four cervical vertebræ. The superior articular surfaces of the atlas are deepened and enlarged by an irregular ledge of new bone. The articular surfaces between the third and fourth cervical vertebræ are similarly increased in extent, but their cartilage has in addition been destroyed, and the surfaces themselves, much increased in area and quite flat, are in some few situations eburnated; over the greater part of their extent they are rendered uneven by numerous small closely-set pits. The inferior articular processes of the fourth

cervical vertebra on the left side are similarly altered. The other articulations, including that between the odontoid process and the atlas, are ankylosed by osseous substance. 161

From a man, 82 years of age, who died after an operation for hernia.

918. The upper part of a right humerus showing the early changes due to rheumatoid arthritis. Around the margin of the articular surface, but more particularly in front, there is a distinct lipping of the margin of the cartilage, which forms a rounded and slightly nodular border. Around the posterior and inferior border of the articular surface the cartilage has been destroyed in a part or the whole of its thickness. On the upper part of the articular surface there is an area in which the cartilage is slightly depressed, darker in colour than that around and slightly roughened.

919. A left scapula, around the glenoid fossa of which a slightly irregular rim of new bone has been formed. The under surface of the acromion is concave, smooth, and polished; over its inner half the dense bone forming it is perforated with numerous circular apertures; the tip of the coracoid process is similarly altered. On both these surfaces the upper end of the humerus has moved, after destruction of the intervening ligamentous structures.

The acromio-clavicular articulation has been similarly affected; a nodule of new bone projects above the articular surface of the acromion.

920. A left scapula, in which almost identical changes have occurred, but the coracoid process is unaffected. 1883

921. A right scapula, in which the glenoid fossa is greatly extended by the formation of a flattened ring of new bone around it. Over a considerable part of its extent the surface is coarsely cancellated, the osseous substance being dense so as somewhat to resemble that formed in the healing of an ulcerated cavity. 3993

922. A right scapula, with the upper third of the humerus. The head of the humerus is surrounded with a border of new bone, and dense new bone has been formed also in an irregular layer upon the tuberosities and along the edges of the bicipital groove. On the anterior part of the great tuberosity is a small eburnated spot, showing that this portion of the bone was in contact with the under surface of the acromion, which is similarly polished—a result possible only after destruction of the tendinous insertions of the supra- and infraspinatus muscles. The glenoid fossa is increased in extent, and its surface rendered uneven by irregular patches of new bone which have been formed upon it; over its upper half it is pierced by minute conical pits, the several depressions being each surrounded with a raised ring of osseous substance. The acromion process presents a long irregularly oval and shallow concave surface, the central part of which is formed by the proper tissue of the acromion, the rest by new bone; with this surface the upper end of the humerus has articulated; at certain points it is pierced with irregular depressions; in one situation it is smooth and polished. 3182

923. The upper half of a right humerus, in which the great tuberosity has been completely destroyed as the result of rheumatoid arthritis, its situation being marked by an almost smooth dense surface. The small tuberosity is diminished in size and irregularly pitted. The upper end of the bicipital groove is wanting and the tendon of the long head of the biceps had probably been destroyed. A rounded bony lip projects from the lower border of the articular surface.

924. The upper part of a right humerus, the head of which is greatly altered in form in consequence of rheumatoid arthritis, being anteriorly almost flattened by absorption. A prominent ring of new bone has been formed around the upper and



posterior borders of this last portion of the articular surface. Both the new osseous tissue and the flattened portion of the head are pierced with small circular and oval apertures. In some situations the new bone is of ivory hardness and smoothly polished, as though the whole surface had articulated with the scapula, which was probably correspondingly altered. The whole bone is light and atrophied. 159

925. The upper part of a right humerus, showing the effects of rheumatoid arthritis. The head is slightly flattened and its borders, especially in front and below, are surrounded by a rim of newly formed cancellous bone, the surface of which is covered with a thin compact layer. The articular surface of the head is dense and irregularly pitted; over its centre the cancellous tissue is exposed along a vertical groove, in front of which the bone is eburnated.

926. A right scapula, with the outer half of the clavicle. The glenoid fossa is surrounded, especially at its lower border, by a very slight rim of new bone. The under surface of the acromion is eburnated and new bone has been formed upon its borders, but in greatest abundance on the extremity of the process, where ossification seems to have occurred in the coraco-acromial ligament. The upper surface of the coracoid process, especially in its inner half, is enlarged and irregular, and articulated with two thick columns of bone formed in connection with the coraco-clavicular ligaments. The inner of these, corresponding to the conoid ligament, is attached to the clavicle, but the outer, which represents the trapezoid ligament, articulates with, but is not united to, the clavicle. The surfaces of the acromio-clavicular joint show but little evidence of disease. 7507

From the dissecting-room.

927. A left scapula and clavicle. The clavicular surface of the acromion is slightly increased in size, very dense, smooth, and polished; in the bone forming it there are several small, circular, oval, and irregular apertures. The corresponding surface of the clavicle is similarly affected. The glenoid fossa is unaltered, except that its lower edge is increased in extent by the formation on it of a layer of new bone. The sternal end of the clavicle and its articular surface are slightly irregular. 3208

928. The bones of a right elbow-joint, in which very extensive changes have occurred from rheumatoid arthritis. The articular parts of the several bones are much enlarged, and the extent of their articular surfaces greatly increased by the formation of prominent ridges and overhanging plates of new bone around them. The articular surfaces are uneven, and in parts slightly tuberculated by the formation of new bone upon them; that of the capitellum is worn almost flat, and is polished and minutely punctated; the corresponding surface of the head of the radius is similarly altered. Transverse ridges of bone which have formed across the olecranon and coronoid fossæ interfere greatly with flexion and extension of the joint. The shafts of the bones are quite healthy. 3157

929. The bones of a right elbow-joint which was affected with rheumatoid arthritis. The articular surfaces have been rendered uneven, or in parts nodular, by new bone formed over them; they are irregularly lipped around their margins. An irregularly transverse fracture of the lower end of the shaft of the humerus has been repaired with slight deformity. 5161

930. A left humerus, the lower end of which is greatly deformed, most probably from long-continued rheumatoid arthritis. In the place of the capitellum there exists a deep semilunar cavity, the surface of which is dense, and over its anterior half smoothly polished, showing it to have formed the articular surface for the upper end of the radius. The outer portion of the trochlear surface also is flattened anteriorly, and vertically ridged; but, except in the situation first mentioned, little new osseous tissue has been formed in the neighbourhood of the altered articular surfaces. 5152

931. The bones of a left forearm. The upper ends are enlarged and tuberos or modulated by the formation of new bone round their articular surfaces, which are considerably increased in area, deepened and tuberculated; in one situation the upper surface of the head of the radius is eburnated. The coronoid process of the ulna is depressed. The shafts and lower ends of the bones are quite healthy. 4753

Many years before death the patient suffered from an injury to the elbow-joint.  
See also No. 775, the bones of the right hip-joint of the same patient.

932. The lower part of a right radius, the articular surface of which is surrounded with a ridge of new bone, by which both its extent and depth are increased. Over the articular surface for the scaphoid the lower end of the radius is deeply concave and eburnated; a few small irregular apertures are scattered over this portion of the articular surface. 142

933. Some of the bones of a hand, showing the effects of rheumatoid arthritis. The magnum and lunar are rendered irregular by ridges of new bone around the articular surfaces; the latter are pitted and in parts eburnated. The bones of the thumb show lipping of the articular surfaces, which in other respects appear normal. Similar changes are seen in the phalanges of the fingers.

934. A wax model of a left hand, showing the appearance of the parts in an early stage of chronic rheumatoid arthritis. In the situation of the first interphalangeal articulations the fingers present smooth fusiform swellings, and both joints of the thumb are similarly enlarged and there is also a slight enlargement of the terminal joints of the index and middle fingers. The metacarpo-phalangeal joints of the fingers are in a position of slight over-extension, whilst those next succeeding are slightly flexed; in the thumb the terminal phalanx is somewhat bent backwards. About the wrist there is a slightly raised wide-spread swelling, indicating that this joint was also affected. 4209

935. The upper part of a right femur longitudinally bisected. Around its head, which has been much reduced in prominence by absorption, a tuberos ring of new bone with overhanging margins has been formed; by this the articular area is greatly increased. The articular surface itself is uneven, but everywhere closed with a layer of hard compact bone, which the section shows to be somewhat thicker than natural. The cancellous tissue is firm, and to all appearance quite healthy. The new osseous tissue so closely resembles the old as to give the head the appearance of having been flattened by pressure.

936. A longitudinal section of the upper part of a left femur, the head of which is flattened and its area increased as a result of rheumatoid arthritis. The lamellæ composing the cancellous tissue of the head are unaltered in direction, and terminate abruptly beneath the compact layer which covers the surface. Upon the upper and anterior aspect of the neck a saddle-shaped process of bone, convex antero-posteriorly and concave from side to side, has been formed; its surface is compact and exactly like that of the head itself, with the substance of which it is continuous; it probably articulated with the upper margin of the acetabulum. The central and lower portion of the head is eburnated, and in places deeply pitted by irregular tracks, around which the osseous tissue appears to be more dense than that forming the rest of the bone. The surface of the eburnated portion has a peculiar tessellated appearance, being composed of polyhedral greyish areas separated by opaque white lines formed apparently by the natural lamellæ of the cancellated tissue, the spaces of which have been filled with dense new bone. In some situations minute apertures exist in the parts between the osseous lamellæ, due apparently to the incomplete filling in of the spaces by the new bone; this condition is more marked below, where not only are the exposed spaces widely open, but the lamellæ have been in part absorbed or destroyed by a process



analogous to ulceration; in the recent state these spaces were probably filled with soft fibroid tissue. The angle of union between the neck and shaft of the femur is reduced almost to a right angle by interstitial absorption of the tissue composing the lower parts of its neck, the highest point of the head lying below the level of the summit of the great trochanter.

937. The upper part of a right femur, the head of which has been for the most part removed by absorption; but the articular area is scarcely diminished in extent, owing to the formation of a rim of new bone around it; the new bone appears like the portion of the head which remains, to have been partly covered with cartilage or fibrous tissue. In two or three situations the articular surface is slightly tuberculated, but is everywhere formed by a layer of compact osseous substance.
938. The upper part of a left femur, the head of which has, on its upper aspect, been flattened by absorption, and its area increased by new bone formed around it. The articular surface is for the most part smooth and very dense. New bone has been formed also around the lower margin of the head, the texture of which it so precisely resembles as to give rise to the appearance of the proper tissue of the head having been displaced downwards over the adjoining part of the neck. The angle of union between the neck of the femur and its shaft is normal, but the neck is so much bent backwards that the limb must have been considerably everted. The tissue of the bone, with the exception of the head, appears to be quite healthy.
939. The upper end of a right femur. Around its head a thin rim of new bone, which overhangs the adjoining portion of the neck, has been formed. The surface of the head, over an elongated oval area on its anterior part, is depressed and uneven, and pierced with irregular, sharp-edged channels, some of which spread deeply into its substance; the highest parts of this area are extremely dense and white, and polished like ivory; in its central part the surface of the head is raised in irregular tubercles. The head of the femur, except over the eburnated area noticed, appears to have been covered with cartilage.
940. The upper end of a right femur. The head is less uniformly rounded than natural, being most prominent in the position of the attachment of the inter-articular ligament. Over a large area anteriorly the articular surface has lost its compact layer, is extensively pitted, and in part eburnated. Around the margin of the articular surface is a prominent overhanging rim of bone, which is most marked above and behind. The neck of the bone is thickened by a deposit of osseous tissue on its anterior surface; its angle with the shaft is normal. 5197
941. The upper end of a right femur. As the result of rheumatoid arthritis the head of the bone has become ovoid in shape. Its articular surface is for the greater part dense and slightly tuberculated; in the upper part it is pitted and eburnated. Around the margin of the articular surface, especially above, there is an irregular formation of new bone. Inferiorly the overhanging rim of bone has become adherent to the surface of the neck, whilst posteriorly a deep hollow is present between the two. Viewed from behind, it is seen that the angle between the neck and shaft of the bone is natural. 3022
942. The upper part of a right femur, the head of which has been almost completely worn away as a result of rheumatoid arthritis; its surface is extremely dense, smooth, and polished; over most of its extent it is marked with small, conical, and irregular pits. An overhanging nodular ring of new bone has been formed around its remains, but scarcely any portion of this is eburnated.
943. The upper end of a right femur greatly deformed in consequence of rheumatoid arthritis. The head forms a coarsely lobulated mass, surrounded by a sinuous

border, and continuous behind with a mass of bone which overlies the posterior surface of the neck. Posteriorly at the root of its neck there projects directly backwards a triangular plate of firm osseous substance, the inner surface of which is concave, and forms part of the general articular area. The whole irregular surface of the head is uneven, dense, and perforated with irregular pits; in two or three spots it is eburnated.

944. The upper third of a left femur, the head and a considerable part of the neck of which, together with the summit of the small trochanter, have disappeared in consequence of rheumatoid arthritis. New bone has been formed in small amount upon the surface around. The elongated articular surface resulting from the removal of the parts noticed is 7.5 cm. in length, and slightly raised over its centre; for the most part it is extremely hard, smooth, white, and glazed like porcelain. 3031
945. A coronal section of the upper end of a left femur, the head of which has been completely removed by rheumatoid arthritis, the articular surface being formed by the remains of the neck and by the new bone which has been formed around it everywhere, except at its upper part. The surface resulting is unevenly convex, rough, and in places perforated with circular apertures 2 or 3 mm. in diameter. The compact tissue of the lower wall of the neck has become for the most part cancellated in texture, and is indistinguishable from the new bone formed below it. 3379
946. A right hip-bone, in which the acetabulum is slightly increased in area, and has been rendered more shallow than natural as a result of rheumatoid arthritis. The articular surface is for the most part uneven and slightly tuberculated. Scarcely a trace of new bone has been formed around its margin.
947. A right hip-bone, around the acetabulum of which a complete ring of new bone has been formed so as to convert the cotyloid notch into a small foramen. At its upper part the articular cavity is hard and polished over an area about the size of a shilling, and below this is for a short distance coarsely reticular; the surface of the acetabulum beyond is evenly concave, and presents all the characters natural to it after removal of its cartilage by maceration, whilst still further downwards an uneven layer of osseous tissue has been formed upon it. 1701
948. A right hip-bone. The acetabulum is enlarged and deepened; its upper half is formed by very dense ivory-like osseous substance, the surface of which is quite smooth and polished; in the lower part of this surface are several small irregular apertures; and its posterior and lower part is rendered uneven by shallow, closely-set, well-defined depressions, in some of which a granular layer of new bone has been formed; the new bone rises above the level of the smoothly-polished surface around. The cotyloid notch is converted into a foramen by a bridge of osseous substance continuous with that formed around the acetabulum.
949. The iliac portion of a right hip-bone, in which the corresponding part of the acetabulum is formed by extremely dense osseous tissue, with a smooth polished surface, in places pitted with irregular undermining depressions. A rugged line of new bone has been formed around the margin of the articular cavity.
950. A right hip-bone, in which the acetabulum is much increased in extent and made deeper than natural by a border of new bone which has been formed around it. Over its anterior half the acetabulum is deeply pitted and cribriform. Many of the apertures lead to wide, irregular, undermining spaces. No portion of the surface is eburnated. 3140
951. Portion of the left hip-bone from the same patient, in which almost similar changes have occurred in the acetabulum. 3139



**952.** A right hip-bone, together with the upper end of the femur. The acetabulum has been so extended, in part by new bone formed around it and in part by the absorption of the bone forming its fundus, as to measure nearly 5 cm. in depth. On the inner aspect of the hip-bone the limit of the articular cavity is marked by a raised oval swelling, as if resulting from a yielding of the floor of the cavity. For its inner half or more the acetabulum is considerably narrower than in the rest of its extent, so as to be conical in form; its surface is almost everywhere reticular, like that of a carious cavity. The cotyloid notch is bridged across by new bone.

The head of the femur is greatly altered in shape and is accurately adapted to the altered shape of the acetabulum. The margins of the articular surface are extensively lipped, and the upper surface is saddle-shaped and presents a uniformly cancellous texture. As the result of the alteration of the head and depression of the neck the highest point of the former is 1.5 cm. below the summit of the great trochanter.

3049

**953.** The bones of a pelvis. On the right side the acetabulum is slightly deepened, and over its upper half has an eburnated and unevenly reticular surface. From each side of the cotyloid notch an expanded plate of new bone has grown so as almost to convert the notch into a foramen. On the left side similar, but much less extensive, changes exist.

Ossification has occurred in the anterior sacro-iliac ligament on the right side, and an irregular formation of new bone has occurred at the margins of the base of the sacrum.

**954.** The bones of a pelvis, with the last two lumbar vertebræ. On the right side the acetabulum has been much increased in extent and depth, in the latter direction by the new bone which surrounds it, the thickness of the bone forming its fundus being increased so as to be double that of the opposite side. Towards its upper part the surface is minutely reticulated. The cotyloid notch is completely obliterated after having been bridged over by the new bone. On the left side the parts present no variation from health, with the exception of a ridge of new bone which has been formed on the upper margin of the acetabulum.

Both sacro-iliac articulations are ankylosed in their upper parts by bone formed in the anterior sacro-iliac ligament. Bony ankylosis has also occurred between the inferior articular processes of the last lumbar vertebra and those of the sacrum, and on the right side between the articular processes of the fourth and fifth lumbar vertebræ.

**955.** The two hip-bones, together with the upper end of the left femur, showing the results of long-standing rheumatoid arthritis. The upper part of the head of the femur, which is irregularly worn away and faceted, is in some parts eburnated and in others deeply pitted. The lower part of the head, which is enlarged by the formation of new bone upon it, presents a densely cancellated surface. This part of the head is separated from the upper eburnated portion by a narrow curved groove, looking almost like a saw-cut in the bone. Except for a narrow strip of its inferior surface, the neck of the femur is ensheathed in a layer of new bone which has evidently formed in connection with the capsule. There is also a dense deposit of new bone about the trochanter and on the anterior surface of the shaft. The left acetabulum is greatly increased in depth by a ridge of new bone formed around its margin and completely bridging over the cotyloid notch. The upper and posterior part of the floor of the space is eburnated and irregularly pitted, and in the rest of its extent the surface presents a densely compact texture.

The right acetabulum is very similarly altered. The cotyloid notch is only incompletely bridged over, its deepest part being closed by a curved plate of dense compact bone. The bone forming the floor of the acetabulum is extensively

excavated, the deepest part of the largest hollow being incompletely closed by a deposit of porous osseous tissue on the inner aspect of the hip-bone. 7258

From the dissecting-room.

956. A right hip-bone, with the upper end of the femur; of the latter a vertical section has been made. The acetabulum is increased in depth partly by absorption of its fundus, which is perforated in two or three spots by small round apertures, but chiefly by the new bone which has been formed above it, and projects as an overhanging widely arched ledge, beneath which the upper end of the femur has moved. The osseous substance forming the cavity is very dense; at some parts it is compact and without apparent apertures; in others it is pierced with minute canals, whilst over the anterior part of the space it has a coarsely cancellated structure. The articular surface of the head of the femur is augmented by a prominent rim of bone which has grown around its margin; the section shows the new bone to be limited by a thin compact layer, and to be continuous with a layer which overlies the natural compact surface of the head, over which it may be traced for a considerable distance, sinking gradually to the level of the natural surface, on the central part of which it is wanting. The osseous tissue of the femur is to all appearance quite natural. 389

957. The upper part of a right femur longitudinally bisected, together with the hip-bone, in both of which considerable deformity has resulted from rheumatoid arthritis. The head of the femur is flattened superiorly so as to be conical or acorn-shaped, but new osseous substance has been deposited all around it so as to considerably increase the articular area. The upper portion of the articular surface is reticular or cancellated, the bone forming it being of almost stony hardness. The neck of the femur, retaining nearly its normal form and direction, is traceable for its entire length on the divided surface overlapped by the new bone, and the upper part of the articular surface is formed by the cancellous tissue of the neck of the femur, the greater part of the head having been removed by friction and pressure. In the hip-bone the acetabulum is rendered very capacious by a prominent rim of bone which has grown upon its border and bridges across the cotyloid notch. Over its upper part the cavity is eburnated, but so extensively perforated that only at a few points is the dense polished surface recognisable. 3047

958. A section of the bones forming a right hip-joint. The superficial portion of the head of the femur has been removed by absorption, its remains being encircled by an irregular ring of new bone. The resulting articular surface, which is considerably greater than that which the head of the femur naturally presents, has been rendered toothed or undulating by the irregular progress of the destructive process; and into the depressions in it new bone has grown from the acetabulum, the extent of which is increased in exact correspondence by an outgrowth of osseous substance around and upon its border. The two surfaces are thus interlocked as by suture, and the joint held immovably in an almost semiflexed position. The osseous tissue for some distance beneath the apposed surfaces is very dense. 2653

959. The other half of the portion of the femur and hip-bone shown in the preceding specimen. 3061

960. A pelvis, together with the upper ends of the two femora. The right hip-joint shows no evidence of disease, but the neck of the femur forms almost exactly a right angle with the shaft, whilst the highest part of the head is nearly 2 cm. below the top of the great trochanter.

The left hip-joint shows extensive changes resulting from rheumatoid arthritis. The acetabulum is shallow, but increased in area; new bone has been formed



around its margin, particularly at the upper part, where there is an irregular spiculated deposit on the outer aspect of the anterior inferior iliac spine. The cotyloid notch is converted into a foramen; the articular surface of the acetabulum is rough and dense and in its posterior part eburnated. The upper extremity of the femur is very greatly deformed, and presents an appearance comparable with that which might be produced by partially melting the head and neck of a wax model of a femur. The head and neck together form an irregular elongated mass which overlaps the inner aspect of the shaft of the bone as low as a point 4 cm. below the small trochanter, whilst the depression for the interarticular ligament is 10 cm. below the summit of the great trochanter. The articular surface of the altered head is extremely dense, being in some parts pitted and in others eburnated.

From a dissecting-room subject.

**961.** A plaster cast of a right hip-bone, in which the acetabulum has been greatly deformed in consequence of rheumatoid arthritis. The articular cavity is spread over an undulating and roughened area about 9 cm. in diameter, extending backwards over both sciatic notches and upwards on the ilium for about the lower third of its extent; inferiorly the articular surface is traceable on the upper part of the body of the ischium, and inwards as far as the margin of the thyroid foramen; in the latter situation traces of the original articular cavity are discernible, and the cotyloid notch remains unaltered. Superiorly the new cavity is limited by a widely-expanded arch of new bone.

**962.** The lower extremity of a right femur. The central portion of the articular cartilage on each condyle and a small area of that on the patellar surface has been destroyed for almost its entire thickness, the subjacent bone being, in one situation on the outer condyle, completely denuded. Around these spots the cartilage is fissured in vertical planes passing radiately from their borders; the edges of the cartilage, as well as those of the fissures in it, are abruptly rounded. The articular cartilage is everywhere devoid of lustre, and has lost its natural smoothness; that which remains within the areas described has a velvety fibrous surface. A revolute border of new bone has been formed upon the margins of the articular surface.

4944

**963.** The lower extremity of a right femur, exhibiting the changes observable in the early stage of chronic rheumatoid arthritis. From the outer part of the patellar surface an oval portion of the cartilage has been worn away, after having undergone fibrous degeneration; the bone exposed is unaltered in appearance. The articular cartilage has in parts a shreddy fibrous surface, whilst in others it is soft and villous. The edges of the cartilage around the space noticed are abruptly rounded and sinuous. On the centre of the outer condyle the superficial portion of the cartilage has been removed, its deeper part, glistening and fibrous, remaining on the bone. Along the margin of the articular surface, except within the intercondylar notch, a low nodulated ridge of small cartilaginous outgrowths has been formed; the newly formed cartilage is in process of ossification.

4934

The patient, a female aged 50, had long complained of pain and stiffness in the knee-joint. She had been for some time in a recumbent posture in consequence of a compound dislocation of the ankle-joint. (Mr. Liston's MS. Catalogue.)

**964.** The lower extremity of a right femur, showing destruction of cartilage as the result of rheumatoid arthritis. Over an elongated area on the inner condyle the cartilage is completely wanting, and the exposed bone is polished and marked by fine grooves running in an antero-posterior direction. Over the adjacent part of the inner condyle and on the inner half of the patellar surface the cartilage has altogether lost its natural appearance, and is replaced by a dense coarsely fibrillated layer which is firmly adherent to the subjacent bone. Over the rest of the articular

surface the cartilage is normal, but around its margin, especially on the internal condyle, is a more or less well-marked cartilaginous lip; the latter is, in parts, overhanging, and its border sinuous or slightly nodular. 6749

From a man, aged 48, in whom amputation through the condyles was performed for diabetic gangrene of the foot. Patient left the hospital 32 days after the operation. (Mr. Beck and Mr. Barker's *Case-books*, 1891, vol. ii. p. 93.)

965. A left patella, together with the adjacent part of the capsule and synovial membrane, from a case of rheumatoid arthritis. The surface of the articular cartilage is very slightly roughened, and around its borders, especially internally, there is a slight outgrowth in the form of a rounded lip. Around the patella the surface of the synovial membrane is for the most part covered with fine fibrous papillæ, many of which are branched and club-shaped at their extremities. The papillæ are largest in the neighbourhood of the infrapatellar fat. 5763

From a dissecting-room subject, aged about 60. There was eburnation of the inner condyle of the femur and the corresponding surface of the tibia. In the opposite knee the cartilage was roughened, but the synovial membrane was not villous. The other joints were healthy.

966. The superior articular portion of a right tibia, together with the semilunar cartilages, showing the effects of rheumatoid arthritis. Along almost the whole length of its free border the internal semilunar cartilage presents numerous fibrous outgrowths, one much larger than the rest being attached to the posterior extremity of the cartilage. A group of fine villi springs from the synovial membrane near the front of the semilunar cartilage. The articular cartilage of the tibia is in part superficially eroded, and, beneath the posterior part of the internal semilunar cartilage, is coarsely fibrillated.

967. A right knee-joint, showing the results of rheumatoid arthritis. All the articular surfaces are increased in area by the outgrowths which have occurred at the margins of the cartilage; this change is most marked in the patella. The cartilage covering the articular surfaces is slightly roughened, especially in the peripheral parts, but is nowhere destroyed in its whole thickness, except in three small, irregular patches on the central part of the articular surface of the femur. Both the semilunar cartilages have become much narrowed as the result of the wearing away of their free borders. The synovial membrane is uniformly thickened, and, especially in that part which covers the tuberosities of the femur, is thickly covered with villous processes. Over the external tuberosity the villi are very delicate, but over the internal tuberosity they are for the most part much larger and club-shaped. 6288

From a man, aged 29, who was admitted into U. C. H., under the care of Dr. Ringer, March 3, 1887, for diarrhoea and albuminuria; there had been pain and swelling in the knees for 2 years; both the joints were full of fluid, and the bones lipped; the elbows and left ankle were also enlarged. No history of rheumatic fever. Death occurred on June 4, and was preceded by diarrhoea and vomiting. There was much emaciation, and the urine was nearly solid with albumen. (Dr. Ringer's *Case-books*, Malcs, 1887, vol. ii. p. 670; and *Trans. Path. Soc.* 1888, vol. xxxix. p. 279.)

968. A left knee-joint, showing the effects of rheumatoid arthritis. The articular cartilage on the femur and tibia has been extensively destroyed, that which remains being opaque and rough. The denuded bone is smooth and polished. On the patella the cartilage is superficially eroded, but has been destroyed in its whole thickness at only one spot. The edges of the articular surfaces present rounded lip-like borders, whilst at the outer margin of the tibia there is a prominent, irregular, cartilage-covered outgrowth, which forms with the outer condylar surface a considerable hollow in which the outer condyle of the femur rested; a smaller flattened outgrowth is seen on the posterior part of the inner condylar surface. The capsule is uniformly thickened, and the synovial membrane, especially around the inner part of the patella, is slightly villous.



The sawn surfaces of the femur, tibia and fibula are uniformly infiltrated with new growth, the upper extremity of the fibula being greatly enlarged.

From a man, aged 68, who died of carcinoma of the œsophagus, with multiple secondary growths in the bones, lymphatic glands, and lungs. Spontaneous fractures occurred in both humeri and in the right clavicle. The left knee was enlarged and could not be completely extended. There was abnormal antero-posterior and lateral movement, with marked grating. The enlargement of the patella and the lipping of the femur and tibia could be readily felt. (Surg. Reg. Rep. 1888, p. 48, No. 2647, and Trans. Path. Soc. 1888, vol. xxxix. p. 278.)

**969.** The lower extremity of a right femur. The articular surface is bordered by a ridge of new bone, which is most marked at the inner edge of the patellar surface and around the intercondylar notch. A thin layer of new bone has also been formed on part of the patellar surface, and in two separate areas on the internal condyle the bone is eburnated.

**970.** The lower part of a right femur. The patellar surface is extended outwards on a revolute border of new bone traceable with interruptions around the whole of the articular surface; over its outer two-thirds the surface of the patella has been worn into a series of vertical grooves, the ridges between which are dense and polished; the greater part of the surface is perforated with irregular closely-set holes, some of them extending for a considerable distance into the substance of the bone. The remaining portion of the patellar surface and the surfaces of the condyles are unaltered, except that a small oval deposit of bone has taken place on the back of the outer condyle.

**971.** The lower end of a left femur, with the patella. From the outer margin of the patellar surface of the femur there has grown a plate of firm osseous substance, the anterior surface of which is dense, smooth, and polished, and in all respects like that of the adjoining portion of the articular surface of the condyle, which has undergone similar changes. The articulation between the two bones is limited to this surface, the patella having been partially displaced outwards. The articular surface of the patella is almost uniformly concave, and very dense, like ivory which has been polished; it is perforated with numerous closely-set, small, circular, and larger, less regular apertures, some of them the openings of tracks which pass deeply into the bone. The border of the patella is surmounted with an irregular ribbon-like process of new bone. The inner portion of the natural patellar surface of the femur has been rendered uneven by an irregular formation of new bone upon it; and new bone has been formed in places also on the margins of the condyles.

**972.** The lower extremities of the femora, together with the patellæ, from the same subject, showing the result of long-standing rheumatoid arthritis. The femora are symmetrically affected in a manner very similar to that in No. 970; the patellar surface is extended outwards on to an overhanging border of new bone, and the surface itself, which is smoothly polished, has been worn into a series of accurately parallel antero-posterior grooves and ridges. Except for the presence of a marginal ridge of new bone, the rest of the articular surfaces of the femora show little change. Both patellæ are altered in shape by the formation of new bone around their borders; their surfaces are polished and grooved so as to be accurately adapted to the patellar surfaces of the femora.

7490

From a dissecting-room subject.

**973.** A right patella, which exhibits various changes due to rheumatoid arthritis. Around its articular surface a narrow line of new bone has been formed; the articular surface itself is in a few spots raised and tuberculated by a formation of new bone upon it; near its outer margin is a small, polished, eburnated area, and scattered over the rest of the surface are small irregular pits, some of which extend deeply within the bone.

**974.** A left patella, the outer half of which is considerably thinned, and its edge worn quite sharp, after destruction of the articular cartilage in rheumatoid arthritis; the corresponding division of its articular surface is formed by very dense white osseous substance, longitudinally grooved and polished like ivory or porcelain. On the inner part of the articular surface is a deposit of new bone, which in places is eburnated.

**975.** The upper parts of a left tibia and fibula, together with the patella, the tibia being extremely altered in shape, most probably as a consequence of rheumatoid arthritis. The upper end of the tibia presents a capacious cup-shaped cavity measuring 8 cm. across its upper part, and extending downwards for almost the same distance below the summit of the head of the fibula. On the inner side the walls of the cavity are formed wholly by new osseous tissue, the outline of the bone towards its upper part being abruptly curved inwards, whilst on the outer side its form is unaltered. The interior of the cavity described is almost everywhere reticulated or porous, but the bone forming it is firm and more dense than natural cancellated tissue. The patella has, by the addition of new bone to its border, become contiguous and interlocked with the edge of the anterior wall of the space in the upper end of the tibia, to which it is united by fibrous tissue; its posterior surface is broadly convex and roughened, with a layer of new bone. Between the tibia and the fibula osseous ankylosis has occurred. It is probable that the lower end of the femur, greatly altered in shape, was received into the cavity in the upper end of the tibia. 5298

From a seaman, 44 years of age. About nineteen years before his first admission into the hospital he fell from the yard-arm and received a large wound on the outside of the left knee; this healed. Two years later, during a voyage, the left knee swelled and became painful for several days; and subsequently the swelling reappeared, and the knee never regained its natural size. At the time of admission an abscess had formed in the thigh and below the patella. Mr. Marshall operated and removed some dead bone. The patient recovered and remained well for two years. A sinus then formed, and he was readmitted into the hospital. The left knee-joint was apparently immovable, but there was great mobility at what appeared to be the lower part of the femur, giving the idea of a fracture. There were three sinuses on the sides and lower part of the knee. A large abscess formed in the thigh, and the patient subsequently died with symptoms of pyæmia. At the post-mortem examination no deposits were found in the internal organs; a long sinus extended from the knee to the hip. The knee-joint was greatly disorganized, the lower end of the femur being almost entirely absorbed, whilst the head of the tibia was expanded into a large cup-shaped cavity, with extensive formation of new bone.

**976.** A right knee-joint, showing changes resulting from gout and rheumatoid arthritis. The cartilage on the patella has been partly destroyed, leaving the bone exposed over many small irregular areas; in one of these areas, which takes the form of a vertical fissure near the centre of the bone, a yellowish granular deposit of urate of sodium is recognisable. On the patellar surface of the femur are several small depressed areas over which the cartilage has been eroded, and a similar but much larger area is situated on the inner condyle. Over other parts the articular surface presents a yellowish, finely granular appearance, due probably to a deposit of urate of sodium in the substance of the cartilage. Similar changes are recognisable in the articular cartilage of the tibia, and yellowish uratic deposits are present on the surface of both semilunar cartilages. A very early stage in the formation of a cartilaginous lip is recognisable around the borders of the articular surface of the femur. The synovial membrane, especially in those parts bordering on the patella and femur, presents an abundant formation of villi on its inner surface; the larger villi consist of coarse, thread-like processes, terminating in flattened, club-shaped, and often branched extremities. The capsule is not thickened. 6305

From a watchman, aged 53, who was admitted into U. C. H., under the care of Dr. Ringer, June 28, 1887. For 10 years he had suffered from chronic rheumatism; for a fortnight before admission there had been swelling of the lower limbs, and a troublesome cough; five days before admission, bright blood was expectorated. The patient was cyanosed, and there was a double aortic murmur and a systolic mitral murmur. Death occurred suddenly on



June 30. The heart was hypertrophied, and the aortic and mitral valves were thickened; the kidneys were tough, the capsule adherent, and crystals of uric acid present. The metatarso-phalangeal joints of the great toes were ankylosed and the cartilage destroyed. (Dr. Ringer's *Case-books*, Males, 1887, vol. ii. p. 471, and *Trans. Path. Soc.* 1888, vol. xxxix. p. 279.)

977. A left knee-joint in which acute suppuration supervened upon chronic rheumatoid arthritis. Over the inner condyle of the femur and the corresponding surface of the tibia the cartilage has been destroyed, and the exposed bone is becoming polished and worn into shallow antero-posterior grooves. Over the rest of its extent, on all the bones, the cartilage is rough and fibrillated. Around the bare patch on the femur, the cartilage presents an abrupt rounded border, and at the margins of the articular surfaces there is a more or less well-marked cartilaginous outgrowth, which in some places, especially along the border of the external condyle, takes the form of a series of smooth, rounded nodules. The inner surface of the synovial membrane, especially in the upper half of the joint, is completely covered with villous processes; the longest of these are 2 cm. in length, and all are club-shaped and branched. In some parts the villous outgrowths are of a dull red colour, as a result of the acute inflammation which occurred in the joint. The capsule is thickened. The popliteal vein is blocked by a decolourized thrombus.

8171

From a man, aged 58, who was admitted into U. C. H., under the care of Dr. Ringer, on the 4th day of an attack of acute pneumonia. There was dulness and tubular breathing over the greater part of the right lung, and both knee-joints were painful and distended with fluid. Death occurred on the day after admission. There was recent inflammatory exudation on both pleuræ and in the pericardium. The right lung was almost everywhere in a condition of grey hepatization. Both knees contained thin purulent fluid. (Dr. Ringer's *Case-books*, Males, 1899, No. 7.)

978. The metatarsal bone and first phalanx of a great toe. Around the articular surfaces of the metatarso-phalangeal joint nodulated and branching outgrowths of new bone have been formed; the surfaces are in parts eburnated and perforated with circular and irregular apertures. The polished portions of the surfaces correspond one with another when the joint is in a position of over-extension and adduction.

3162

979. Horizontal sections of two great toes removed from different subjects, showing changes in the metatarso-phalangeal joints caused by rheumatoid arthritis, and associated with hallux valgus and bunion. In both specimens the cartilage covering the head of the metatarsal bone has been in part destroyed; in one of them, similar but less marked changes are present on the base of the first phalanx. In both, some irregular outgrowths have formed around the articular surface on the metatarsal bone. The first phalanx is, in each specimen, strongly adducted, so that its base articulates only with the outer half of the head of the metatarsal bone. As a result of this displacement the inner part of the latter projects unduly, and, together with the thickened capsule and the skin and subcutaneous tissue over it, forms a prominent swelling (bunion) over the inner aspect of the metatarso-phalangeal joint. In one specimen a well-marked bursa has formed on the outer surface of the capsule, and in the same specimen the whole substance of the head of the metatarsal bone is sclerosed.

5609, 5706

980. The heads of six metatarsal bones variously altered as the result of rheumatoid arthritis. The changes shown in the different specimens are the formation of prominent lips or irregular bony outgrowths around the articular surface, alterations in shape, eburnation and pitting of the articular surface.

## GOUT.

The earliest change observable in a joint, as the result of gout, is a deposit of urate of sodium in the form of delicate needle-shaped crystals in the substance of the cartilages. These appear to the naked eye as white specks, first seen in the superficial layers of the cartilage, but afterwards extending more deeply. In a more advanced stage the whole cartilage may be of a chalky white colour. In some cases the opposed cartilages may be slightly worn away by friction, but more commonly they remain unaltered in thickness. In extreme cases of gout the deposit is not limited to the cartilage, but occurs also in the synovial membrane, ligaments, and periarticular tissue. It may then accumulate in vast quantities, forming the masses known as chalk-stones or tophi (991).

In rare cases urate of sodium is also found in the cancellous tissue immediately beneath the cartilages (993).

The joint most often affected first is the metatarso-phalangeal articulation of the great toe (982); after that the other joints of the foot and the knee. The hand and elbow are also frequently affected (991).

981. The metatarsal bone with the first phalanx and sesamoid bones of a great toe, the articulation between which was the seat of several attacks of gouty inflammation. The articular cartilage covering the several bones is speckled and roughened with opaque white grains of urate of sodium deposited in it, and rendered prominent by the drying of the cartilage. There was no deposit externally to the joint. The ends of the bones and the sesamoid bones are enlarged, and the surface of the head of the metatarsal bone is irregular. 4308

From a patient, 75 years of age, who had suffered from attacks of gout for 30 years, but in whom the disease had never assumed a chronic form, nor induced any stiffness. No other joints, except that shown, were examined. (See Garrod on "Gout," 3rd ed., Case 10, p. 172.)

982. The bones forming the metatarso-phalangeal joints of the great toes. In the right toe the articular cartilage is slightly roughened over its central parts by a deposit of urate of sodium. 4309

From a patient, 50 years of age, who died of disease of the heart. No other joints but that shown were affected, and that twice only, with gouty symptoms. One of the two attacks occurred three and a half, and the other two and a half years before death. (Garrod on "Gout," Case 15, p. 178.)

983. A wax model of a left great toe and adjoining part of the foot, representing the appearance of "tophi" or "chalk-stones" formed in the neighbourhood of its joints, the skin over which is raised in oval tuberos swellings by the deposit of urate of sodium beneath it; the deposit appears to have taken place also in the skin itself, which is mottled with opaque white patches over the most prominent parts of the swellings. The joints were also affected. 4114

984. Wax models of the pinnae from the same case as the preceding. In the left ear are seen four deposits of urate of sodium in the border of the upper part of the helix; in the right ear a single but larger deposit is seen in a similar position. 4115

From a man, aged 57, a house-painter, who had suffered from lead colic. For 12 years he had had repeated attacks of gout in many joints. (Garrod on "Gout," p. 61.)

985. The bones of a left knee-joint, and those forming the metatarso-phalangeal joint of each great toe. In the articular cartilages of all of them urate of sodium has been copiously deposited. In the right toe the cancellous tissue of the bones



is in several places exposed; and urate of sodium appears to have been deposited in the open cancellous spaces.

4307

The patient, aged 49, had eight attacks of gout, affecting chiefly the lower extremities, but had been free from any attack for eighteen months before death, which took place from ascites caused by cirrhosis of the liver. There was no stiffness, nor was there any deformity or appearance of urate of sodium externally upon the ears or elsewhere. Both the knees exhibited the deposit, as likewise did the kidney. (Garrod on "Gout," Case 11, p. 173.)

986. The bones of a left knee-joint, which was the seat of one slight attack of gout. The articular cartilage on the several bones has almost everywhere either lost the transparency natural to it in the dried state, or is of a faint whitish colour, owing to the deposition of urate of sodium in its substance; the same material has been deposited also in minute grains upon its surface, giving to the parts an appearance as if powdered. The semilunar fibro-cartilages are affected in a similar manner, and along their inner edge are milky white and semiopaque.

4310

The patient had many attacks of gout in the feet, but only one slight attack in the left knee. The other joints and the kidneys also showed deposits. (Garrod on "Gout," Case 12, p. 174.)

987. The articular surface of the lower end of a left femur, in the cartilage of which urate of sodium has been deposited so as thickly to encrust the central parts.

4311

988. A wax model of the bones entering into the formation of the right knee-joint, together with the kidneys, from the same patient as the preceding. Urate of sodium has been deposited on the articular surfaces of all the bones, in largest amount in the cartilage of the femur, which is almost covered with an uneven mortar-like layer. On the condylar surfaces of the tibia the deposit is confined to the peripheral parts. The soft tissues surrounding the joint appear to have been more than naturally vascular. Both the kidneys are contracted and slightly granular; in one of them the Malpighian pyramids are represented as streaked with chalk-like urates, and small cysts appear to have been scattered through its cortical part.

4214

From a man, aged 55, a compositor, who had been subject to gout affecting many joints for 15 years. (Garrod on "Gout," Case 1, p. 154.)

989. The bones of a right foot, with the adjoining ends of the tibia and fibula, around the several joints of which, but in greatest abundance about the first metatarso-phalangeal articulation, gouty concretions have been formed. The morbid substance has accumulated largely in front of the ankle, and must have rendered the joint quite immovable. The peroneal tendons lie embedded in a mass of similar white, friable, chalk-like substance.

990. A wax model of a left hand, in which the fingers are considerably deformed by gouty concretions formed round their interphalangeal articulations. In the course of the extensor tendons, and probably deposited around them, are prominent oval swellings, similar to those which lie upon the articulations.

2553

991. A wax model of a left hand and forearm. Around the joints of the thumb and fingers uratic deposits have accumulated in large amount so as to give rise to great tuberculous swellings, which occupy almost the entire length of the fingers and extend around the extensor tendons for a considerable distance on the back of the hand; in this situation, on the radial side, is a knobbed oval swelling, measuring about 6 cm. in the transverse direction. At the back of the elbow there is a similar lobulated oval swelling about 8 cm. in length and projecting nearly 4 cm. above the surrounding surface. The skin over the several deposits is unaltered in appearance.

2761

From a man, aged 67, a servant, who had been the subject of gout for 31 years; the concretions about the hands and elbows had been forming for 14 years. (Garrod on "Gout," p. 62.)

992. Plaster cast of a right hand, in which all the fingers are greatly deformed by uratic deposits formed around their articulations. The most extensive deposit has occurred across the whole width of the back of the hand over the metacarpo-phalangeal articulations. 5947

993. The metacarpal bone of a little finger, together with part of the first phalanx and pisiform bone and some of the surrounding muscles and tendons; and also a section of the head of one of the first metatarsal bones. Over the dorsal aspect of the metacarpo-phalangeal joint of the little finger is an extensive deposit of urate of sodium, which at its deepest part involves the extensor tendons and at one spot is exposed in an ulcer of the overlying skin. A similar but smaller deposit partly surrounds the pisiform bone, and extends in fine lines into the tendon of the flexor carpi ulnaris and to a less extent invades the small muscles of the little finger. No deposits are present in the joints of the finger nor on the articular surface of the pisiform bone.

Deposits of urate of sodium are seen in the cartilage covering the head of the metatarsal bone, and where the cartilage is absent similar deposits extend into the cancellous tissue. Extensive concretions are also present in the capsule of the metatarso-phalangeal joint. 5687

From a man, aged 64, who died of malignant disease of the œsophagus. He had had an attack of gout lasting 9 weeks, two and a half years before death. (Dr. Ringer's *Case-books*, Males, 1881, p. 992.)

#### NEUROPATHIC AFFECTIONS OF JOINTS.

Organic changes in joints are occasionally met with in association with disease of the nervous system. This association occurs most commonly in certain chronic affections of the spinal cord, of which locomotor ataxy and syringomyelia are by far the most important. The joint-changes occurring in these two affections are very similar, but the articulations most commonly affected are different. Thus in locomotor ataxy the joints of the lower extremities, especially the knee, are chiefly affected; whilst in syringomyelia the joints of the upper extremities, especially the shoulder, chiefly suffer. The earliest change is usually a considerable effusion of fluid into the joint, and this is often rapidly followed by more or less complete disorganisation. In some instances the chief change is an extensive erosion and loss of substance of the articular extremities of the bones, which, together with the relaxation of the ligamentous structures, results in an extraordinary degree of mobility of the joint and a tendency to dislocation.

In other cases the changes are more hypertrophic in character. Associated with erosion of the cartilages and subjacent bone, there is thickening of the capsule and periarticular tissues, and often considerable overgrowth of the synovial fringes, with the formation of pedunculated or loose bodies (994, 996). At the same time a more or less extensive formation of new bone may occur around the altered articular surfaces.

994. A left knee-joint in coronal section, showing the changes occurring in Charcot's disease. The joint is greatly enlarged as the result of thickening of its capsule, but without any great distension of its cavity, and, after marked alteration in the shape of the articular extremities of the femur and tibia, dislocation has occurred in such a way that the upper extremity of the tibia lies to the outer side of the lower extremity of the femur, the two bones overlapping to the extent of about 8 cm. The upper end of the tibia has undergone extensive loss of substance, affecting chiefly its inner part, so that the bone presents a long oblique surface of contact with the femur. Correspondingly in the latter bone the loss of substance has involved chiefly the outer condyle, the inner condyle being considerably enlarged. The enlargement



of the lower extremity of the femur extends upwards to the adjacent part of the shaft, where a section into the bone shows the osseous tissue to be very dense in texture. Irregular plates of bone project from the posterior aspect of the thickened part of the shaft, that on the inner side being evidently formed in the substance of the adductor magnus.

The capsule of the joint is very greatly thickened, forming a dense fibrous layer, which in parts is nearly 2.5 cm. in thickness. The inner surface of the capsule presents numerous large lobulated fibrous masses and smaller flattened processes, hanging freely into the joint and evidently representing hypertrophied synovial fringes. The joint also contains several large calcareous bodies; one of these lying in contact with the upper surface of the tibia is loose in the joint, but the others are attached to or embedded in the thickened capsule. No normal cartilage remains on any part of the articular surface of the femur; it is replaced by a dense smooth fibrous layer about 4 mm. in thickness, similar in appearance to the inner surface of the capsule and directly continuous with it.

That part of the tibia which is included within the joint is covered with a similar but thicker fibrous layer, which extends downwards to a distance of more than 10 cm., at which level the thickened capsule is reflected from the bone. The muscular and other soft structures in relation with the posterior aspect of the joint are greatly thickened and intimately adherent to the fibrous capsule.

8072

995. The anterior half of the same joint. The anterior surface of the patella is roughened by a new osseous deposit, and its cartilaginous surface is completely hidden by a fibrous layer continuous with and indistinguishable from the inner surface of the capsule. The ligamentum patellæ, although deeply embedded in the front of the thickened capsule, is itself unaltered in appearance. Two small ulcers are present in the thickened skin over the upper part of the tibia. They correspond in position to the lowest part of the capsule, and probably resulted from the irritation of a large calcareous mass which lies beneath the skin. 8072

*Microscopic Structure.*—The capsule and the fibrous layer which covers the articular surfaces in place of the cartilage consist of dense fibrous tissue containing considerable numbers of small elongated cells. A section of one of the polypoid outgrowths from the capsule which had not undergone calcification shows it to consist of dense fibrous tissue in which the fibres are undergoing a granular degeneration.

From a woman, aged 53, who was admitted into the St. Pancras Infirmary in April 1898, under the care of Dr. Arthur Chilcott. There was a history of a strain five years previously, and of a second injury three months later. There was no history of any symptoms of locomotor ataxy, but the condition of the knee had for many months prevented the patient from walking. The knee-jerks were absent, and the pupils presented the Argyll-Robertson phenomenon. The limb was removed by amputation on July 11; the wound healed well, but the patient was unable to wear an artificial limb as the slightest pressure on the buttock caused sloughing of the skin. No other joint was affected.

996. The bones entering into the formation of a right hip-joint which was affected with Charcot's disease. Great alterations have taken place in both the femur and hip-bone. In the former the head and nearly the whole of the neck have disappeared, the new articular surface being formed by the remains of the neck above and the small trochanter below. The greater part of this surface is covered with tough shaggy fibrous tissue, but in those parts which are uncovered the bone is dense and smooth but not eburnated. The acetabulum is deep, and as the result of dislocation of the upper extremity of the femur upwards and backwards the articular surface has been extended for more than 2.5 cm. in that direction, and is overhung by an irregular rim of new bone rising to a height of about 2.5 cm. This rim extends along the posterior margin of the joint, and is continuous with a bridge of bone across the cotyloid notch. The articular surface presents appearances similar to those described in the femur, and no part of the articular cartilage remains.

The capsule is loose and greatly thickened, and has attachments to the bones in correspondence with the altered extent of the articular surfaces. Thus on the hip-bone its upper attachment corresponds to the osseous ridge above mentioned, whilst on the femur its lowest limit is around the lower border of the small trochanter. The inner surface of the capsule is in most parts covered with closely-set villous processes varying much in length and thickness. Attached to it also are numerous bony masses, one of which, much larger than the rest, measures 4.5 cm. in its greatest diameter and appears to have occupied the hollow of the acetabulum. The surrounding bones show here and there slight irregular thickenings; a blunt process of bone nearly 4 cm. in length projects upwards from the ischial spine, and a large irregularly branched bony plate has formed in the substance of the upper end of the vastus internus muscle.

From a man aged 57. The disease of the hips had begun—the right eight years and the left six years before death—with what was called “erysipelas” of the thigh; this was soon followed by loss of strength in the lower limbs and shortening. The other symptoms were loss of sexual power and frequent severe “bilious attacks.” Death was preceded by violent sickness, swelling of the hands, numbness of the thighs, and suppression of the urine. (Richard Quain’s ‘Clinical Lectures,’ p. 104, Case 25.)

997. Plaster cast of a right foot. The foot is flattened, and that part which corresponds to the tarsus enlarged. The four outer toes are contracted. 8309

From a case of locomotor ataxy. (Gowers, ‘Diseases of the Nervous System,’ 2nd edition, vol. i. p. 412.)

998. An atrophied foot removed by Pirogoff’s amputation, and divided by a sagittal section, the soft parts being separated from the bones. The foot is not only greatly reduced in size, but has entirely lost its normal shape, as the result of shortening in an antero-posterior direction to such an extent that the extremity of the great toe is scarcely more than 2.5 cm. in front of the astragalus. The foot is thus reduced to a mere rounded club, from the front of which the toes project; the latter are all greatly atrophied and contracted. The nails of the first and second toes are normal in appearance; those of the three outer are wanting. On the outer aspect of the sole, in the position in which apparently pressure was chiefly borne, is an ulcer measuring about 2.5 cm. by 1.5 cm.; the skin around this is greatly thickened and in parts coarsely velvety. The skin elsewhere is normal, except across the dorsum of the foot, where it is pigmented and presents deep transverse folds.

The astragalus and the remains of the os calcis are but little altered in shape, but the former is tilted so that its long axis is nearly vertical. The navicular, three cuneiforms, and the remains of the bases of the 2nd, 3rd, and 4th metatarsal bones are fused into an irregular mass, the outline of the individual bones being almost entirely lost. The cuboid is separate and has an irregular surface corresponding to the ulcer in the integument. The base of the first metatarsal bone is about normal in size, the shaft being represented merely by a small projection. The fifth metatarsal bone is entirely wanting. All the toes appear to contain the atrophied remains of the phalanges. Many of the ligaments of the tarsus have been dissected out and present a normal appearance. In most parts the remains of the tarsal bones are soft and fatty. The cartilage in those joints which are not ankylosed is thin and eroded at the margin. 6679

From a woman aged 35. The general health was good. The history of the deformity was very vague and incomplete; it was said to have been present since the age of 20. The foot was removed by Pirogoff’s amputation. When the patient was discharged on the 58th day there was still a small granulating surface in the middle of the scar. The changes were probably neuropathic in nature. (Surg. Reg. Rep. 1890, pp. 110, 198, No. 677.)



## LOOSE BODIES IN JOINTS.

These are of the following varieties :—

1. Fibrous bodies, resulting from enlargement and induration of the processes of the synovial fringes. These bodies may reach a considerable size, and are usually attached to the synovial membrane by a fibrous pedicle (999). They may be met with in association with various chronic inflammatory affections of the joints, and probably in some instances result from injury.
2. Melon-seed bodies. These are usually numerous, white or brownish in colour, and closely resemble the seed of a melon in form (1009). Fine grain-like bodies of a similar nature are also met with (1010). These bodies are composed of dense fibrinous material. They are supposed to arise from changes occurring in blood or inflammatory products effused into the joint, and are especially apt to be associated with certain forms of tuberculous disease. Similar bodies may possibly arise from hypertrophy of the fringes of the synovial membrane detached by the movements of the joint.
3. Cartilaginous and osseo-cartilaginous bodies, formed in connection with the synovial membrane. They may be cartilaginous throughout, or may contain a nucleus of true bone (1005); sometimes the cartilage is calcified (1003). These bodies are supposed to arise from an overgrowth of the microscopic traces of cartilage found in some of the secondary processes of the synovial fringes, or from plates of cartilage formed in the subsynovial tissue in connection with rheumatoid arthritis. They may be free in the joint or attached to the synovial membrane. Loose bodies of this kind are usually single, but occasionally two or three may be found.
4. Fragments of articular cartilage separated as the result of injury. These are more rare; they are recognised by their shape, and often by the fact that they show traces of osseous tissue on one surface only (1009), as well as by the arrangement of the cartilage-cells (1006).

**999.** A loose body, shaped somewhat like a suprarenal capsule, and measuring nearly 4 cm. in length, which was removed from a knee-joint. It has a smooth glistening exterior, obscured for the most part by a thin layer of pale, buff-coloured, homogeneous substance, which in places has been removed, and in others raised in shreds from the surface.

The loose body is composed exclusively of coarse fibrous tissue, in which, under the microscope, a few groups of fat-cells are discernible. 3865

It was removed by Mr. Liston from the knee-joint of a man 28 years of age, in whom the movement of the joint was much impaired, the joint itself being considerably swollen. The use of the limb was completely regained after the operation.

**1000.** An irregularly disk-shaped body measuring nearly 4 cm. in length, which was removed from the knee-joint. On section, it is seen to consist chiefly of dense fibrous tissue, but on one surface small lobules of fat are present. Around some parts of the margin of the growth coarse villous processes project. The body appears to have been extensively attached to the capsule of the joint over the surface above mentioned on which the fatty lobules are present. 5493

From a woman, aged 38, who had suffered from pain and swelling in the right knee for 4 years. No history of injury. There was fluid in the joint, and a movable body could be felt above the patella. The joint was opened by a vertical incision above the outer border of the patella, and the body, which was attached to the capsule, excised. Nineteen days later the knee was aspirated and some blood-stained fluid withdrawn. Discharged on the 34th day. (Mr. Heath's *Case-books*, 1880, vol. ii. p. 144.)

- 1001.** A flattened mass of calcareous substance, or of very dense bone, which lay loose in the cavity of a knee-joint. One of its surfaces is slightly convex; the other is somewhat irregularly hollowed, and is covered with a transparent layer of dried tissue as if a part of the loose body had been formed of a softer, more destructible substance. Its edge, excepting in one situation, is smooth and regular. The body measures about 2.5 cm. in the longest diameter. 3564

The patient, a man 30 years of age, had a loose body in each knee-joint; that in the right was extracted by Mr. Liston. After the operation the patient passed a very restless night, and on the third day violent inflammation supervened, with extensive swelling of the thigh and upper part of the leg. Suppuration in the joint followed, and there was profuse discharge of pus and synovia. Recovery took place very slowly. The knee-joint became ankylosed.

- 1002.** A large fibrous mass and several loose bodies removed by operation from the knee-joint. The large mass measures 8 by 6 cm., and is 2 cm. in thickness; it is composed of very dense fibrous tissue, which, especially around the margin, projects in the form of finely lobulated masses of almost cartilaginous hardness. At its upper part it presents a shreddy fibrous process, by which it appears to have been attached to the synovial membrane. The smaller bodies consist of lobulated masses of dense fibrous tissue, to some of which long and delicate threads are attached. One small kidney-shaped body appears to have been unattached; it is composed of dense hyaline fibrous tissue, intersected with yellowish areas, probably due to fatty degeneration. 7828

Examined microscopically the large fibrous mass consists in parts of richly cellular connective tissue and in other parts of dense hyaline tissue containing few cell-elements. In some of the bodies calcareous degeneration has taken place. The synovial membrane is highly vascular.

From a woman, aged 39, admitted into U. C. H. June 18, 1897. The right knee had been painful at intervals and always swollen since a fall 20 years previously. On admission, the right knee was much enlarged, especially at the upper and inner part; the capsule and ligaments were relaxed; there was no apparent excess of fluid; numerous loose bodies were felt, and a large nodular mass in the supra-patellar pouch; there was no lipping of the bones and no grating. On July 1 lateral incisions were made into the joint, and numerous loose bodies and the nodular mass above mentioned were removed. The synovial membrane was covered with diffuse warty growths, many of which were removed. Iodoform emulsion was applied and the incisions partly sutured. Discharged on July 26. (Mr. Barker's *Casbooks*, 1897, vol. ii. p. 245.)

- 1003.** Two large, irregular, calcareous bodies from a knee-joint. 5787

From a dissecting-room subject. The knee-joint was the seat of rheumatoid arthritis.

- 1004.** A small, slightly lobulated, loose body removed from a knee-joint. The section shows that the body consists chiefly of cartilage, in the substance of which, and nearly exposed on one surface, is a yellower area composed of bone. 5672

From a man, aged 56, in whom attacks of pain and swelling of the right knee had occurred at varying intervals since a twist of the joint 40 years ago. On admission the joint was full of fluid and a movable body could be felt in it. An incision was made and the body removed, about 2 ounces of fluid being evacuated. There was still a good deal of fluid in the joint when the patient was discharged in the 20th day. (Surg. Reg. Rep. 1881, p. 63.)

- 1005.** Part of a loose body as large as a filbert-nut, removed from a knee-joint. It consists of cancellous bone, thickly coated with cartilage except at one end, where the bone is exposed and looks as if it had been broken. 6135

From a man, aged 42, in whom pain and swelling of the knee followed a jump from a platform on to the railway. The loose body could be felt, and was fixed with strapping in the lower and internal pouch of the joint. It was successfully excised by Mr. Beck. (Surg. Reg. Rep. 1885, p. 97.)

- 1006.** A disk-shaped cartilaginous body, measuring 4 cm. in its longest diameter. On one surface it is smooth and slightly convex, and around its border presents a



slightly nodular rounded outgrowth exactly similar to that seen around the articular cartilage in joints affected with rheumatoid arthritis; the outgrowth is much more marked along one border of the body than along the other; the other surface of the body is irregular, and the section shows that in this part calcification has occurred, and that near one extremity a small nodule of bone is embedded in the cartilage.

6905

G. B., a coachman, aged 43, was admitted into U. C. H. under the care of Mr. Godlee in 1892. Nine years previously the left knee became stiff after a fall; two months later, after another fall, "something seemed to give way" and the knee could again be bent. Since that time a movable body could be felt in the joint. Two months before admission the knee became swollen and painful after another fall. The body lay in the upper and outer part of the joint; it was freely movable and grated on the surface of the femur. The movements of the knee were free; the patella was large and the condyles of the femur were lipped. The body was excised; it was quite unattached. Examined microscopically the arrangement of the cartilage-cells was like that in normal articular cartilage. (Mr. Beek and Mr. Godlee's *Case-books*, 1892, vol. ii. p. 319.)

1007. A small disk-shaped body, 2 cm. in diameter, removed from a knee-joint. On one surface the body is cartilaginous, smooth, and slightly convex; on the other surface it is bony and rough. Along one border the cartilage presents a distinct vertical striation and sharp contour as if recently fractured.

6856

A. E. B., aged 23, a postman, was admitted into U. C. H. under the care of Mr. Heath, May 24, 1892. Three weeks before admission he fell on a slippery board, striking the inner side of the right knee; on the same day and on the following day he had difficulty in bending the knee. Subsequently the loose body was felt and a catching sensation in the joint was experienced in walking. On admission a freely movable body could be felt in the knee above the patella; the movements of the joint were free and smooth, and the bones not enlarged. The loose body was excised. Discharged on 11th day. (Mr. Heath's *Case-books*, 1892, vol. ii. p. 30.)

1008. Six small bodies, which were found beneath one of the semilunar cartilages of a knee-joint. The largest of them is deep yellow, translucent, and composed of a delicate framework of osseous substance filled with fat; it may have been a nodule of bone which had been detached from an outgrowth around the articular surface. The others are polyhedral in shape as if mutually adapted, and are formed of opaque, white, earthy substance; a section which has been made of one of them displays a laminated arrangement of the substance composing it, similar to that presented by some of those in the following specimen, which it is probable the bodies just described represent in a condition of calcification.

4654

The articular surfaces of the femur and tibia were natural, excepting that the cartilage had disappeared from the anterior surface of the inner condyle, which was porcellaneous.

1009. Several flattened bodies from a knee-joint, most of them approaching an oval form, the largest measuring nearly 1.5 cm. in length. All of them consist of a firm, structureless, friable substance of a pale brown colour; some are concentrically laminated.

3691

The bodies escaped with the pus from a diseased knee-joint when laid open. The limb was subsequently amputated by Mr. Liston.

1010. A large number of minute grain-like bodies removed by aspiration from an elbow-joint.

8310

From a man, aged 26, in whom swelling of the right elbow followed a fall. On admission into U. C. H. there was a fluid swelling on the posterior aspect of the joint; it was punctured and subsequently drained; glairy fluid, containing small grain-like bodies, was evacuated. The joint remained painful and movement impaired; six months later, on Nov. 2, 1897, excision of the joint was performed by Mr. Godlee. The synovial membrane contained tubercle systems with large giant-cells. The patient was re-admitted in February 1899 on account of swelling about the false joint of 2½ months' duration. A short incision was made over the posterior aspect of the false joint, and a large number of melon-seed bodies were removed. (Mr. Godlee's *Case-books*, 1897, vol. i. p. 157.)

## ANKYLOSIS OF JOINTS.

When a healthy joint is kept fixed for a sufficient length of time it becomes stiff, and on being forcibly moved adhesions which have formed between the two surfaces are felt to give way with a loud crackling. The same condition is still more marked if the joint have suffered from slight inflammation unaccompanied by any destructive changes. In these cases the adhesions between the two surfaces have the appearance of a delicate homogeneous membrane-like layer (1011). In recovery from acute traumatic inflammation, or any of the subacute or chronic forms of disease accompanied by destruction of the cartilages, the articular surfaces become more or less firmly united together by fibrous tissue or bone. Union by fibrous tissue, or *fibrous ankylosis*, occurs in those cases in which the cartilages have not been completely destroyed (1012), or in which there has been a want of absolute immobility in the treatment even though complete destruction of the cartilage has occurred (1013). The immobility of the joint is not due merely to the new fibrous tissue existing between the two surfaces, but also to a thickening and contraction of the surrounding ligaments (1018).

Union of the two surfaces by bone, or *bony ankylosis*, occurs in those cases in which the cartilages have been more or less extensively destroyed, so that the cancellous surfaces of the two bones have been in actual contact and have remained for a sufficient time in a fixed position (1029, 1034).

In well-marked cases of bony ankylosis the cancellous tissue of the bones becomes continuous, and is surrounded by a compact layer, so that the exact limits of the two bones cannot be defined (1041).

In a fourth class of cases the joint becomes fixed by the formation of new bone around it without any apparent disease of the articular surfaces. The new bone in these cases seems to be formed by ossification of the ligaments (1055 *et seq.*).

(a) *Simple Adhesions.*

1011. The lower ends of the bones of a right leg, the articular cartilage of which is covered with a thin, smooth, membranous layer of pale yellow substance, which around the edges has been peeled off from the subjacent cartilage. In the middle of the joint a folded layer of similar substance has been raised from the surface. The compact substance of the bones is slightly atrophied; their cancellous tissue has been removed in making the preparation. 383

There appears to have been no active disease in the joint, and the layer by which the articular surfaces have become adherent has been formed most probably in consequence of long-maintained immobility of the parts, by reason of some other disease.

(b) *Fibrous Ankylosis following Destructive Disease of a Joint.*

By far the most common cause of fibrous ankylosis is tuberculous disease. It may also follow acute suppurative arthritis.

1012. The right elbow-joint of a boy, in which the cartilage of the several articular surfaces has been extensively destroyed, the exposed bone being also superficially ulcerated. The portions of the articular cartilage remaining have in parts been almost detached from the subjacent bone in the preparation of the specimen; they present no obvious change, except that in a few situations they are thinly covered with a delicate fibroid or granulation tissue. A layer of new bone, nodulated in the vicinity of the disease, has been formed upon the different bones. 386

From a boy, who, whilst in the hospital for disease of the elbow-joint, was seized with abdominal inflammation, of which he died. After death the caecum and greater part of the ascending colon were found to contain a large collection of trichurides.

The elbow-joint was united by firm adhesions, which were removed by the maceration of the specimen.



- 1013.** A right hip-bone, with the upper end of the femur. Their corresponding articular surfaces have been destroyed by ulceration, which has hollowed the head of the femur and deeply excavated its surface. Each of the articulating surfaces is covered with glistening fibrous tissue, by which the parts appear to have been firmly united. On the inner aspect of the hip-bone is displayed the sac of an abscess formed beneath the obturator internus; the inner wall of the abscess appears to be formed by the periosteum raised from the bone and greatly thickened; a few flakes of inflammatory exudation adhere to the denuded bone, which appears to form the opposite wall. The abscess is limited above by the brim of the pelvis; posteriorly it does not pass beyond the great sciatic notch, whilst below it is limited by the margin of the obturator foramen. A piece of whalebone has been passed through a small aperture in the bottom of the acetabulum, by which the abscess within the pelvis communicates with the hip-joint. The capsule of the joint appears to have been greatly thickened. 5011
- 1014.** The left hip-joint of an adult, in which, after considerable destruction of the head of the femur and the acetabulum, the parts have been united by fibrous tissue, the cavity of the joint being completely obliterated; the connecting tissue has been forcibly torn, and the head of the femur withdrawn from its socket. 3684
- 1015.** The hip-joint of an adult. The head of the femur has been much altered in form, its anterior half having been almost wholly removed by previous ulceration, and its remains rendered evenly concave in adaptation to the rounded upper margin of the acetabulum, with which it has come in part to articulate; from this portion the articular cartilage has been removed by ulceration, but the surface of the bone is almost smooth and compact, and was probably covered with fibrous tissue; fibrous ankylosis has occurred between the lower portions of the articulation. The floor of the acetabulum is much thickened by new osseous tissue formed on the inner aspect of the corresponding portion of the hip-bone, the articular cavity itself being scarcely diminished in depth; the divided surfaces of the thickened bone are uniformly cancellous, showing the parts to have been long inflamed. The capsule of the joint is considerably thickened. The femur is flexed to the fullest possible extent. 536
- 1016.** A vertical section of a left knee-joint, injected, in which, after complete destruction of the articular cartilage and superficial caries of the subjacent bone, the several parts have become firmly united by fibrous tissue developed from the granulations formed on the diseased surfaces. The rest of the articular cavity is obliterated by similar fibrous tissue formed from the granulation-tissue which replaced the synovial membrane. The crucial ligaments are not recognisable; probably they have been destroyed, the fibrous tissue in their situation being of new formation. 374
- 1017.** The other half of the same knee-joint. 375
- From a patient in whom the knee was affected with tuberculous disease. The patient had left the hospital and was able to walk some months before he died from an attack of erysipelas.
- 1018.** The bones of a left knee-joint, the cavity of which has been completely obliterated by fibrous tissue formed from the granulation-tissue which has covered the bones after destruction of their articular surfaces. Posteriorly the new tissue has become osseous, the condyles of the femur being here continued without interruption into the upper end of the tibia. The soft parts surrounding the knee are much thickened. 5125
- 1019.** The bones forming the right knee-joint of a child, between which ankylosis has occurred with great deformity, the joint being semiflexed, and the tibia both rotated and subluxated outwards. The patella rests upon the outer surface of the external condyle. The several bones are much atrophied from disuse. 1102

**1020.** A left astragalus with part of the os calcis. The upper articular surface of the astragalus shows various changes due to inflammation of the ankle-joint. Except for a narrow marginal line the articular surface and subjacent compact layer of bone have been destroyed, a tough and, as shown by the injection, somewhat vascular fibrous tissue having been formed in their place, by which the joint has apparently been ankylosed. Around the margin of the articular surface the bone, where exposed by destruction of the cartilage, is almost unaltered in appearance, and in two or three places narrow strips of the cartilage remain upon it. On the lower aspect of the bone the cartilage covering the posterior division of the astragalo-calcaneal articulation has been destroyed around its margin, and the subjacent osseous tissue laid bare. On the corresponding surface of the os calcis the cartilage is also deeply furrowed and in parts destroyed in its whole thickness. On the anterior calcaneal articular surface of the astragalus there is a patch of tough fibrous tissue, by which the apposed parts of the bones forming the articulation were probably adherent; the cartilage itself is quite healthy. 381

**1021.** The ends of a right humerus and ulna which enter into the formation of the elbow-joint. The capitellum of the humerus and adjoining portion of the trochlea are surrounded with a low ridge of bone, produced, apparently, in the new tissue formed between the articular surfaces after superficial destruction of the bone. In the situation of the olecranon fossa the humerus is perforated by a circular aperture about 5 mm. in diameter; above this its shaft presents on the outer side a small, ill-defined, oval swelling; and upon the periarticular surfaces of both bones nodules and points of new osseous substance have been formed.

*(c) Osseous Ankylosis following destructive disease of a joint.*

Osseous ankylosis occurs less commonly than fibrous ankylosis as a result of tuberculous disease and acute suppurative arthritis. The layer of granulation-tissue intervening between the bones after destruction of the cartilage undergoes direct ossification. Osseous ankylosis occasionally occurs as a sequel of different forms of arthritis of infective or traumatic origin in which the inflammation pursues a mild course and is unattended with any evidence of suppuration.

**1022.** Part of the right side of a skull, with the condylar portion of the lower jaw. The latter is immovably united, as if by suture, to the corresponding part of the temporal bone, the contiguous surfaces being very irregular, but mutually adapted, and separated in part by a thin line of shrunken fibrous tissue. Considerable portions of each of the surfaces have been destroyed; the condylar part of the jaw is much enlarged in the antero-posterior direction, so as to lie in contact both with the glenoid fossa and the articular eminence in front of it. The new bone is dense and indistinguishable from that forming the rest of the jaw. 2451

From a woman 30 years of age. The jaws were sufficiently apart to admit of her being fed with a spoon. The specimen was obtained from a subject brought into the Dublin dissecting-room.

**1023.** An occipital bone, with which the atlas has become completely united by osseous tissue, probably after destruction of the corresponding articular surfaces. The anterior root of the transverse process of the atlas on each side, that of the left in part only, is wanting; the central portion of the arch of the atlas is also wanting. In relation to the atlas, the occipital bone is slightly rotated and inclined towards the left side. The inferior articular surfaces of the atlas bear in all respects a natural appearance. 3265

**1024.** The vertebrae of a cervical region, with part of the occipital bone. The series of articulations between them is firmly ankylosed by bone so as to convert the whole into a continuous solid column. The natural curve of the column is obliterated, and the ankylosis has apparently resulted, in part at least, from ossification



of the ligamentous structures around the articulations. Upon the anterior surface of the bodies of the vertebræ new bone has been formed in longitudinal bands corresponding with the fasciculi of the anterior common ligament; the transverse ligament of the atlas and the ligaments passing between the odontoid process and the occipital bone have also been converted into osseous substance. Spiculated masses of new bone have been formed, apparently as a result of inflammation, in other parts, especially about the articular processes of the fourth, fifth, and sixth vertebræ, at the root of the odontoid process posteriorly, and in front between the axis and atlas.

**1025.** Part of the base of a skull, together with the atlas. On the left side the atlas is immovably united to the occipital bone by osseous substance. A thick column of bone passes upwards from the extremity of the transverse process of the atlas to the occipital bone, and a thin band of compact bone connects the tubercle on the anterior aspect of the atlas with the margin of the foramen magnum. The ankylosis has probably resulted from disease of the atlanto-occipital articulation. The articulation on the right side is unaffected, as are also the inferior articular surfaces of the atlas and that against which the odontoid process of the axis rests.

4973

**1026.** Two specimens of the 2nd and 3rd cervical vertebræ. In each of them bony ankylosis has occurred between the two bones at every part with the exception of the pedicles and transverse processes. In the larger specimen there is a slight lateral inclination of the vertebræ towards the right side, apparently due to loss of substance from destruction of the bodies on the same side.

14

**1027.** The bones of a right elbow-joint, in which osseous union has occurred, as a result of destructive disease. The radius is semipronated, and the elbow is fixed at an obtuse angle.

3892

**1028.** A vertical section of the bones of a right elbow-joint, ankylosed after destruction of their articular surfaces. The tissue, both compact and cancellous, of the several bones is uniformly continuous. The angle of the ankylosed joint is rather greater than a right angle, and the head of the radius lies below the external condyle.

3026

**1029.** The corresponding ends of a left humerus and ulna continued one into another by osseous tissue which has formed between them. The lower end of the humerus is considerably altered in shape, presenting anteriorly a prominent ridge, which is continuous with the coronoid process of the ulna. The head of the radius and the capitellum of the humerus have been considerably altered in size and form, the radius being partially dislocated backwards; the apposed surfaces are mutually adapted and closed with a layer of compact bone; they were probably united by fibrous tissue.

3700

**1030.** The bones of the left elbow-joint of a child, ankylosed by osseous substance formed between and around them after destruction of their articular surfaces. The section shows their tissue to have become throughout continuous. The joint is flexed almost to a right angle, and the radius is semipronated.

1053

**1301.** A left humerus, with the ulna and radius. Between the first two osseous ankylosis has occurred, apparently after some destruction of their contiguous articular parts. The bones are united at a slightly obtuse angle. The head of the radius is wholly wanting, and the neck of the bone rested on a small facet above the capitellum. All the bones are atrophied.

3703

**1032.** The lower part of a left humerus, with the proximal ends of the bones of the forearm. A large V-shaped portion of the humerus, including nearly

the whole of the trochlea, has been destroyed; a considerable part of the articular portion of the ulna has in like manner disappeared; from each side of the V-shaped notch in the lower end of the humerus, columnar masses of bone extend to the ulna and firmly unite the two bones. The head of the radius and the surfaces with which it articulates are superficially rarefied; a short sinus leads from the small sigmoid cavity into the large open space between the ulna and humerus. It is not improbable that some of the destruction of the ends of the bones last mentioned has taken place subsequently to their ankylosis. 3099

1033. A left hip-bone with the upper end of the femur; the latter, almost semiflexed and adducted, is completely ankylosed to the hip-bone. The natural configuration of the parts is unchanged beyond the alteration produced by ossification of the ilio-femoral and capsular ligaments. In the situation of the cotyloid notch no union of the parts has occurred: in this situation the surfaces have been destroyed by ulceration, and they have probably been similarly affected over the rest of their extent. A deposit of new bone on the front of the joint is longitudinally grooved, apparently in adaptation to the tendon of the ilio-psoas. 3262

1034. A left hip-bone with the upper end of the femur, between which osseous union has occurred after disease of the hip-joint. The acetabulum has apparently been perforated, the inner surface of the hip-bone in this situation having healed after superficial caries; a sinus, the walls of which are smoothly healed, leads horizontally through the hip-bone, a short distance above the spine of the ischium. The joint is flexed almost to a right angle, and the femur greatly adducted. The natural curve of the brim of the pelvis is considerably altered, the pubic portion of the bone forming almost a right angle with the ilium. As in the preceding specimen, the ilio-femoral ligament is represented by a ridge of bone, apparently formed by its direct ossification. The small trochanter is united by a mass of new bone to the superior pubic ramus. 3093

1035. A right hip-bone and femur, conjoined into a single mass after extensive destruction of the parts forming the hip-joint; the femur is flexed and so rotated that its anterior surface looks directly outwards; and it is also considerably abducted. The ilium is much increased in thickness, and the inner surface rendered convex as the result of interstitial expansion of the bone. The shaft of the femur has been fractured near its middle, the lower fragment being displaced backwards and upwards, and united to the upper with much angular deformity; the union of the parts is strengthened anteriorly by a flattened columnar mass of new bone passing from the pointed end of the upper fragment to the front of the lower. The medullary canal of the upper portion is widely open. The lower end of the femur appears to have been united to the tibia by fibrous tissue after considerable destruction of the articular surface.

1036. A section of the bones of a hip-joint, in which osseous ankylosis has followed destructive disease of the joint. The compact and the cancellous tissues of the bones are continuous without interruption. The femur is flexed almost to a right angle and adducted.

1037. A section of the bones of a hip-joint. The upper end of the femur, greatly enlarged by long-continued inflammation, has, after destruction of the articular surfaces forming the joint, become united to the hip-bone, there being no interruption in the texture forming the two. The cavity of the acetabulum appears to have been considerably enlarged, and it is most likely that its floor was perforated in the situation of an irregular nodulated oval mass of osseous substance formed upon the hip-bone on the inner aspect. The femur is flexed to



a right angle and slightly abducted. The thyroid foramen is enlarged by atrophy of the bones forming it.

3066

**1038.** The other half of the preceding specimen.

**1039.** The lower part of a left hip-bone, with the upper end of the femur. The femur is semiflexed and adducted, and has been united by osseous substance to the hip-bone after being slightly displaced upwards and backwards so that the lower part of the acetabulum is unoccupied. A considerable mass of new bone is thrown out around the ankylosed joint.

**1040.** The corresponding ends of a left femur and tibia, together with the patella, partial osseous ankylosis having occurred between the bones after recovery from destructive disease of the knee-joint. The several bones have been forcibly parted; the knee-joint appears to have been flexed to an angle of between  $110^{\circ}$  and  $120^{\circ}$ . The articular surfaces are very uneven, and in many situations deeply pitted as if by the removal of small sequestra. The patella has been fixed upon the outer condyle of the femur. There are no signs anywhere of progressing caries, except perhaps in the little pit in the front of the outer condylar surface of the tibia.

2921

The patient recovered after amputation.

**1041.** The bones of a right knee-joint; of the femur and tibia a coronal section has been made. The several bones have become ankylosed by osseous tissue over the whole extent of their contiguous surfaces, after superficial destruction of their articular parts. The knee is bent to a right angle, the tibia being also displaced and slightly rotated outwards; the patella is partially dislocated outwards so as to leave the inner half of the patellar surface of the femur uncovered. The ulcerated articular surfaces, where not ankylosed, have for the most part healed; where ankylosed the cancellous tissue of the femur and tibia has become uniformly continuous. In the cancellous tissue of the upper end of the tibia, but separated by a considerable distance from the articular surface, there is an irregular, somewhat oval space, 2.5 cm. in length, the walls of which are formed by curling lamellæ and rods of osseous substance arranged vertically to, but continued without interruption into, the subjacent cancellous tissue. The cavity may have resulted from a localized central rarefactive osteitis, the inflammation stopping short of suppuration, and being followed in its recovery by ossification of the granulation-tissue.

2639

**1042.** The bones of a left knee-joint, between which osseous ankylosis has occurred as a result of destructive articular disease; the bones themselves appear to have been only superficially affected. Between the articular surfaces of the tibia and femur the union is complete, a narrow tunnel through the middle of the ankylosed joint alone remaining. The patella, as is almost invariably the case in ankylosis of the knee-joint, is united to the outer margin of the patellar surface of the femur. The facet for the fibula is unaltered. The union of the bones has occurred in the extended position.

**1043.** The lower half of a left femur, with the upper half of the tibia and the patella. The several bones are ankylosed very much as in the preceding specimen; the tibia, however, is displaced slightly backwards and rotated outwards, the knee being also slightly flexed. In the lower end of the femur a sequestrum of the cancellous tissue has been in part detached; two cloacæ lead from the cavity in which it lies, one through the anterior, the other through the posterior wall of the bone. These cloacæ are in close proximity to the articular surfaces, and either of them may have opened into the cavity of the knee-joint, the destruction of which has probably been consequent upon such an event. The shaft of the femur is enlarged in its lower 15 cm., and its thickened walls have

become extremely dense from long-continued inflammation. The edges of the posterior cloaca are rounded and healed; those of the anterior are everted, but the bone forming them exhibits no marks of active disease. 3886

1044. The bones of a left knee-joint, which have become continuous by osseous substance formed in the reparative process following destructive disease of the joint. The knee is bent to a right angle, and the tibia rotated considerably outwards. The remains of the patella are united to the lower part of the patellar surface of the femur and adjoining part of the outer condyle; a considerable portion of the latter has been destroyed during the progress of the disease. 3883

1045. The bones of a right knee-joint, in which bony ankylosis has occurred in a position similar to that present in the last specimen. The outward rotation of the tibia is, however, more marked. There is no evidence that the patella was united to the femur. 6706

1046. Plaster cast of the bones forming a knee-joint, in which great deformity has occurred in consequence of articular disease. The tibia appears to have been united by bone to the femur after having been slightly flexed and subluxated backwards; the tibia has also been rotated outwards so as to leave its outer condylar surface, which lies behind the corresponding condyle of the femur, uncovered. The patella has been completely dislocated outwards, and appears to have been united by bone to the outer surface of the external condyle of the femur, being rotated so that its anterior surface looks directly outwards.

1047. Plaster cast of a left knee in which considerable deformity has occurred, most probably as the result of long-standing disease of the joint. The bones were united in a position of slight flexion, and at the same time the head of the tibia was drawn somewhat backwards and outwards and the leg rotated outwards. The tendons of the hamstring muscles form prominent ridges on either side of the popliteal space.

1048. The lower third of a right femur, with the bones of the leg and the patella, osseous ankylosis having occurred between the several bones. The limb is in a remarkable position of over-extension, the tibia forming almost a right angle with the femur. On the front of the lower end of the femur is a mass of cancellated bone representing the remains of the patella, and from this a thick rounded ridge of compact osseous substance, evidently the ligamentum patellæ ossified, extends directly downwards to the tubercle of the tibia. The fasciculi of the ligament are distinctly recognizable, and even a delicate fascia passing across its middle, which has also undergone ossification. At the posterior margin of the lower articulation of the tibia there is a flattened surface with which the astragalus or some outgrowth from it articulated, this extension of the natural surface having been produced as the result of a partial dislocation caused by the over-extension which must have been necessary in order that the foot might be brought to the ground. 5004

1049. A right tibia and fibula united at their upper articulation by osseous substance. No union has taken place between their lower ends. 5198

1050. A right tibia and fibula, immovably united at their upper ends by bone. No osseous union has occurred between their lower ends. 4583

1051. The upper halves of a right tibia and fibula, between the corresponding articular surfaces of which osseous ankylosis has taken place. The condylar surfaces of the tibia are superficially rarefied. 3878



**1052.** The lower half of a right tibia, with the astragalus, united by osseous substance formed between them after destruction of their articular surfaces in disease of the ankle-joint. The inferior surface of the astragalus behind the groove for the interosseous ligament has been made very uneven by caries.

**1053.** The lower ends of a left tibia and fibula, with the astragalus and os calcis. The portions of the astragalus and os calcis forming the posterior astragalocalcaneal articulation have been extensively and irregularly destroyed, the upper part of the os calcis being hollowed and deeply pitted; the bones were probably in part united by fibrous tissue. Osseous ankylosis has occurred between the astragalus and the contiguous parts of the tibia and fibula; the latter bones are also united at their lower ends by osseous substance. The apex of the internal malleolus and the portion of the tibia above its base have apparently been destroyed; the portion of the malleolus remaining is traversed by a wide vertical channel.

3225

From a woman, 32 years of age, who had disease of the foot for a long time; several sinuses leading to dead bone had formed. The patient recovered after amputation of the foot.

**1054.** The lower ends of the bones of a right leg, with the astragalus and os calcis. In the portion of the tibia shown there is an irregular flattened space, from which a sequestrum of cancellous tissue has probably been removed. The tibia is considerably enlarged, its medullary canal obliterated, and the shaft converted into a solid mass of coarse cancellous tissue bounded by a layer of compact bone much thinner than that which naturally forms the wall of this part of the bone, the changes having occurred as a result of long-continued inflammation. About 5 cm. above, and slightly anterior to, the inner malleolus there is a slit-like aperture in the wall of the tibia 2 cm. in length, the lower part of which appears to have healed; it has probably been made with a saw. The cavity opens also anteriorly by a small oval smooth-edged aperture situated immediately above the level of that just noticed.

The several bones entering into the formation of the ankle-joint are completely ankylosed by osseous tissue, probably in consequence of secondary disease of the joint. The tibia and fibula are, moreover, united by bone above their lower articulation.

3197

(d) *Osseous Ankylosis not manifestly due to destructive disease of a joint, and resulting apparently from ossification of the ligaments surrounding the articulation.*

This form of ankylosis is most common in old age, and is chiefly found affecting the articulations of the ribs, vertebral column, and pelvis (1055, 1057, 1062). The cause of the change is usually uncertain, but not uncommonly it is associated with rheumatoid arthritis.

**1055.** Eight dorsal vertebræ. Along the middle line and over the right side osseous substance has been formed upon their bodies in columns corresponding with the bands of the anterior common ligament; over the adjacent margins of their bodies the osseous substance has been heaped up so as to form jutting, horizontal ridges, which have, in most situations, coalesced and form a series of prominent bosses upon the front of the spine, the several parts of which are immovably held together. The articulations are unaffected.

1282

**1056.** The fourth and fifth vertebræ of a lumbar region, immovably conjoined by an oval mass of bone formed on one side upon the adjacent borders of their bodies.

**1057.** The last three dorsal vertebræ, with the adjoining ends of the eleventh and twelfth ribs of the left side. The heads of the ribs are united to the bodies of the vertebræ by bone formed probably in the ligamentous structures which surround

the articulations. Irregular masses of new bone have been formed around the facets for the ribs on the right sides of the tenth and eleventh vertebræ. A layer of new bone has been formed also on the left sides of the bodies of the vertebræ, in greatest amount near their adjoining margins, so as to unite them into a single mass, but the intervertebral articulations are unaffected. The new osseous substance is transversely grooved below the head of each rib by the passage of the intercostal and lumbar arteries.

1058. Two dorsal vertebræ, with part of a rib on either side. The heads of the ribs are immovably joined with the bodies of the vertebræ in consequence of ossification of their connecting ligamentous structures. On the left side the lower half of the articular surface of the rib is exposed; it is scarcely altered in appearance.

1059. The lower part of a sternum with parts of the costal cartilages of the left side. The chondro-sternal articulations have become ankylosed by ossification of the fibrous structures passing over them; the formation of new bone has been continued for some distance on the costal cartilages. On the right side of the sternum new bone has been formed round the articulations, but not so as to cause ankylosis; and the articular surfaces, except that they are deepened by the new bone, present no unnatural appearance.

1060. A manubrium sterni, with the first pair of ribs. By ossification in connection with the perichondrium the ribs have become continuously united by a sheath of bone to the sternum. The manubrium is considerably altered in form, its upper edge being rendered convex by a dense nodular outgrowth of new bone. The articular surfaces for the clavicles are much widened and irregular in form; that on the left side is covered by dense bone slightly eburnated, the appearances of the surfaces being such as accompany long-standing rheumatoid arthritis. 3037

1061. A left os magnum and unciform bone, with the three inner metacarpal bones. The several articulations between the bones are ankylosed by osseous substance formed around them in bands and fasciculi corresponding with their ligaments; in several places in the intervals between these, spaces exist between the articular surfaces, which present no appearance of having been diseased. The ankylosis has apparently extended also to the neighbouring bones. 2887

1062. A right hip-bone, with the corresponding half of the sacrum and last lumbar vertebra. The hip-bone is united to the sacrum by a broad layer of bone, formed apparently in the anterior sacro-iliac ligament. The lower half of the articulation is open, and its surfaces do not appear to have as yet become anywhere continuous, and there is no evidence of any destructive disease having occurred at any time in the articulation. The last lumbar vertebra also is ankylosed to the ilium by a mass of bone occupying the position of the ilio-lumbar ligament. 1992

1063. The right halves of the last dorsal and the lumbar vertebræ together with the adjacent part of the pelvic bones. The articular processes of the several vertebræ are ankylosed, as also are their bodies, by ossification of the ligamentous structures passing over them; the body of the fifth lumbar vertebra is also united to the sacrum. The sacro-iliac ligaments have also been converted into bone. Within the vertebral canal plates of bone have been formed in the situation of the ligamenta subflava. There are no appearances of any ulceration or destructive inflammation having occurred in the parts concerned.

1064. The upper extremities of a right tibia and fibula, united by strong columns around the articulation between them. The articulation itself does not appear to have been diseased. 5704

From the dissecting-room.





## INDEX TO PART I.<sup>1</sup>

---

ABSCCESS, cerebral, 63.

Achondroplasia, 633-641.

Acromio-clavicular articulation, rheumatoid arthritis of, 174, 183, 919, 927.

Acute infective osteomyelitis. *See* Acute infective suppuration of bone.

Acute infective periostitis. *See* Acute infective suppuration of bone.

Acute infective suppuration of bone, 51, 346, 371, 398, 401-404, 406, 446-469, 531.

    "    "    "    of special bones. *See under the several bones.*

Acute necrosis. *See* Acute infective suppuration of bone.

Ankle-joint, acute suppuration of, 827.

    "    ankylosis of, 327, 908, 1011, 1020, 1052, 1053, 1054.

    "    dislocation of, 318, 322, 323, 324, 809, 810.

    "    gout of, 989.

    "    tuberculous disease of, 836, 841, 907, 908.

Ankylosis of joints, bony, 70, 157, 228, 279, 327, 343, 461, 483, 487, 489, 490, 500, 501, 503, 506, 532, 565, 843, 866, 867, 917, 953, 954, 975, 998, 1022-1064.

    "    "    fibrous, 838, 908, 1011-1021.

    "    of special joints. *See under the several joints.*

Arthritis. *See* Inflammation of Joints.

Astragalus, atrophy of, 343.

    "    excision of, 814, 815.

    "    dislocation of, 811-815.

    "    fracture of, 327, 811, 814.

    "    gunshot fracture of, 86.

    "    necrosis of, 827.

    "    syphilitic disease of, 565.

    "    tuberculous disease of, 368, 532, 836, 840, 841, 908, 912.

Atrophy of bone, 33, 192, 250, 305, 332-345, 461, 794, 832, 841, 844, 886, 889, 924, 998, 1011, 1019, 1031.

BRAIN, abscess of, 63.

Bunion, 979.

Bursa, gout of, 991.

CARCINOMA of bone, columnar-cell, 750.

    "    "    spheroidal-cell, 55, 740, 743-749, 751.

    "    "    squamous-cell, 752, 753, 764, 765, 968.

Carpus, ankylosis, 866, 867, 1061.

    "    dislocations, 796.

    "    rheumatoid arthritis, 933.

    "    tuberculous disease, 517, 866, 867, 869.

---

<sup>1</sup> The numbers refer to the specimens.





Femur, osseous tumours of, 662, 663, 675-680.

„ osteitis deformans of, 650.

„ rickets of, 604-606, 608, 616, 618-622, 632.

„ sarcoma of, fibro-sarcoma, 688.

„ „ mixed-cell, 694.

„ „ myeloid, 730, 731.

„ „ ossifying and chondrifying, 650, 715, 716, 721, 722, 728.

„ „ round-cell, 699, 701, 704.

„ „ spindle-cell, 691, 692, 693, 698.

„ syphilitic disease of, 264, 375, 566-573.

„ tuberculous disease of, 52, 525-529. *See also* Hip-joint, Knee-joint.

Fibro-sarcomata of bone, 687-689.

Fibula, achondroplasia of, 640, 641.

„ atrophy of, 33, 305, 338, 345, 841, 1011.

„ carcinoma of, 968.

„ fractures of, 6, 22, 26, 33, 34, 39, 40, 41, 48, 49, 303, 305-312, 314, 316, 318-321, 327, 379, 420, 421, 632. *See also* Pott's fracture.

„ necrosis of, from fracture, 39, 379, 421.

„ „ from injury, 400.

„ „ doubtful, 445.

„ rickets of, 608, 616, 624, 625, 632.

„ syphilitic disease of, 547, 548, 549, 550.

„ tuberculous disease of, 531, 838, 897. *See also* Ankle-joint.

Fœtal Cretinism. *See* Achondroplasia.

Foot-bones. *See* Tarsus, Metatarsus, Phalanges.

Fractures, 1-327.

„ from bites of animals, 87.

„ gunshot, 57-86.

„ irregular repair of, 25-49.

„ of special bones, 93-327. *See also under the several bones.*

„ spontaneous, 50-56, 344, 355, 607, 608, 632, 691, 692, 697, 704, 720, 728, 744, 746, 748, 750.

„ union of, 11-24.

„ varieties of, 1-10.

Gout, 976, 981-993.

„ of bursa, 991.

„ of special joints. *See under the several joints.*

Gunshot fractures, 57-86.

HALLUX VALGUS, 979.

Hand-bones. *See* Carpus, Metacarpus, Phalanges.

Hip-bone, acute infective suppuration of, 452.

„ atrophy of, 886, 889.

„ excision of, 52, 365, 891, 892.

„ fractures of. *See* Pelvis.

„ necrosis of, from acute infective suppuration, 452.

„ „ from tuberculous disease, 524, 881, 892.

„ osseous tumour of, 684.

„ osteitis deformans of, 649.

„ rickets of, 606.

„ sarcoma of, 649, 706.

„ tuberculous disease of, 523, 524. *See also* Hip-joint, Sacro-iliac articulation.

Hip-joint, acute arthritis of, 452, 775.

„ ankylosis of, 1013-1015, 1033-1039.

„ Charcot's disease of, 996.

„ dislocations of, spontaneous, 775, 879, 884, 889, 996.

„ „ traumatic, 800, 801, 802.

„ „ of uncertain origin, 776, 777, 1039.

„ neuropathic affections of, 996.



Hip-joint, rheumatoid arthritis of, 775, 935-961.

„ tuberculous disease of, 874-892.

Humerus, achondroplasia of, 635, 638, 641.

„ acute infective suppuration of, 371, 467, 468.

„ atrophy of, 192, 924, 1031.

„ carcinoma of, columnar-cell, 750.

„ „ spheroidal-cell, 748.

„ „ of uncertain variety, 56.

„ fractures of lower extremity of, 199, 200.

„ „ shaft of, 5, 11, 13, 35, 37, 45, 50, 54, 56, 194-198, 422, 632, 720, 748, 750, 929.

„ „ spontaneous, 50, 54, 56, 697, 632, 720, 748, 750.

„ „ upper extremity of, anatomical neck, 190.

„ „ „ „ great tuberosity, 188, 189.

„ „ „ „ surgical neck, 191-193, 616, 697.

„ gunshot fractures of, 70-75.

„ necrosis of, after fracture, 37, 45, 72, 73, 198, 422.

„ „ from tuberculous disease, 839, 846.

„ „ of uncertain cause, 409, 436.

„ osseous tumour of, 666, 667.

„ rickets of, 607, 608, 615-617, 628, 631, 632.

„ sarcoma of, chondrifying and ossifying, 720, 723, 724.

„ „ fibro-sarcoma, 687.

„ „ mixed-cell, 697.

„ „ myeloid, 735, 754.

„ „ round-cell, 703.

„ „ spindle-cell, 54.

„ syphilitic disease of, 541.

„ tuberculous disease of, 515. *See also* Shoulder-joint, Elbow-joint.

Hypertrophy of bone, 328-331, 794.

ILIUM. *See* Hip-bone, Pelvis.

Inflammation of bone, acute and chronic, effects of, 346-374.

„ „ „ „ in periosteum (periostitis), 346-353.

„ „ „ „ in compact bone (osteitis), 354-363.

„ „ „ „ in cancellous bone (osteitis), 364-370.

„ „ „ „ in medulla (osteo-myelitis), 371-374.

„ „ chronic, conditions inducing, 375-396.

„ „ „ „ osteoplastic, 375-387.

„ „ „ „ rarefactive, 388-396.

„ „ special bones. *See under the several bones.*

„ „ joints, acute suppurative, 289, 290, 393, 450, 452, 775, 816-829, 977.

„ „ „ specific. *See* Tuberculous Disease, &c.

„ „ „ special joints. *See under the several joints.*

Ischium, fractures of. *See* Pelvis.

„ tuberculous disease of, 524. *See also* Hip-joint.

JAW, lower, ankylosis of, 1022.

„ „ atrophy of, 340, 341.

„ „ deformed from pressure of tumour, 762, 766.

„ „ fractures of, 31, 142-148.

„ „ necrosis of, from fracture, 31, 148.

„ „ „ upper, altered by growth of tumour, 765, 766.

„ „ necrosis of, from syphilis, 588, 593, 594.

„ „ syphilitic disease of, 588, 591, 592, 593, 594.

„ „ tuberculous disease of, 472.

KNEE-JOINT, acute suppuration of, 289, 290, 450, 817, 819, 828, 829, 977.

„ ankylosis of, bony, 279, 461.

„ „ „ fibrous, 838, 904, 1016-1019, 1040-1048.

„ arthrectomy of, 902, 904, 906.

- Knee-joint, Charcot's disease of, 994, 995.  
 " dislocations of, spontaneous, 994, 1019, 1041, 1043, 1046.  
 " " traumatic, 808. *See also* Patella.  
 " excision of, 899-901, 903-905.  
 " gout of, 976, 985-988.  
 " loose bodies from, 999-1009.  
 " neuropathic affections of, 994, 995.  
 " rheumatoid arthritis of, 962-977.  
 " tuberculous disease of, 830-835, 838, 842, 893-906, 1016, 1017.

LOOSE BODIES from joints, 999-1010.

- METACARPUS, ankylosis, 866, 867.  
 " enchondroma, 656-658, 660.  
 " gout, 991-993.  
 " sarcoma, myeloid, 734.  
 " tuberculous disease, 867. *See also* Carpus.

- Metatarsus, atrophy, 332, 998.  
 " dislocation, 979.  
 " fracture, 325, 326.  
 " gout, 981-983, 985, 989.  
 " necrosis from tuberculous disease, 537.  
 " neuropathic affections, 998.  
 " rheumatoid arthritis, 978-980.  
 " sarcoma (fibro-sarcoma), 689.  
 " tuberculous disease, 535, 537, 914. *See also* Tarsus.  
 Mollities ossium, 642-645.

- NASAL bones, fracture of, 139-141.  
 " " necrosis of, from syphilis, 589.  
 " " syphilitic disease, 588, 589, 591.  
 " " tuberculous disease, 471.  
 " septum, syphilitic disease of, 591, 594.

Necrosis of bone, 397-445.

- " " changes associated with, 397-413.  
 " " conditions inducing, 414-432.  
 " " " " acute infective suppuration of bone, *q. v.*  
 " " " " amputation, 372, 392, 412, 425-430.  
 " " " " fracture, 31, 37, 38, 39, 40, 41, 42, 43, 44, 45, 72,  
 73, 74, 77, 80, 83, 107, 148, 198, 275, 309, 327, 379,  
 420-424.  
 " " " " injury, 400, 414-419.  
 " " " " suppuration in soft parts around, 89-92, 347, 407, 431,  
 432, 827, 829.  
 " " " " syphilis, 397, 399, 413, 559, 583, 584, 588, 589, 590,  
 593, 594, 600, 601.  
 " " " " tubercle, 364, 365, 381, 491, 499, 510, 517, 519, 521,  
 522, 524-528, 530, 532-534, 537, 837, 839, 840, 842,  
 846, 858, 866, 870, 871, 875, 881, 890, 892, 895, 896.

Neuropathic affections of joints, 994-998.

- " " " Charcot's disease, 994-997.

OS CALCIS, atrophy of, 343.

- " excision of, 533.  
 " fracture of, 327.  
 " necrosis of, 364, 532, 533.  
 " sarcoma of, 708.  
 " syphilitic disease of, 565.  
 " tuberculous disease of, 364, 368, 532, 533, 840, 908.



Osseous tumours of bone. *See* Tumours.

Osteitis. *See* Inflammation of bone.

„ deformans, 646-654.

Osteomalacia, 642-645.

Osteomyelitis. *See* Inflammation of Bone.

PATELLA, dislocations of, 803-808, 971.

„ excision of, 829.

„ fractures of, 30, 285-299.

„ necrosis of, from suppuration around, 829.

„ sarcoma of, mixed-cell, 700.

„ tuberculous disease of. *See* Knee-joint.

Pelvis, achondroplasia of, 634, 640.

„ fractures of, 223-229, 800.

„ mollities ossium of, 642, 643, 644.

„ rickets of, 614, 632.

„ tuberculous disease of. *See* Hip-bone, Hip-joint, Sacro-iliac articulation, Spine.

Periostitis. *See* Inflammation of Bone.

Phalangeal bones and joints, of fingers, acute arthritis, 822, 823, 824, 825, 826.

„ „ „ cartilaginous tumours, 655, 657, 658, 659, 660.

„ „ „ dislocation, 798, 799.

„ „ „ fracture, 222.

„ „ „ gout, 990, 991, 992.

„ „ „ necrosis, from suppuration around, 431, 432.

„ „ „ „ from tubercle, 519, 521, 522.

„ „ „ rheumatoid arthritis, 933, 934.

„ „ „ sarcoma, melanotic, 741.

„ „ „ „ myeloid, 756.

„ „ „ tuberculous disease, 373, 518-522.

„ „ of toes, atrophy, 998.

„ „ „ fracture, 914.

„ „ „ gout, 989.

„ „ „ neuropathic affections, 998.

„ „ „ osseous tumours, 668-672.

„ „ „ tuberculous disease, 536, 913, 914.

Pott's fracture, 318, 320, 322, 323, 324.

Pubis, fractures of. *See* Pelvis.

„ tuberculous disease of, 873. *See also* Hip-joint.

RADIUS, achondroplasia of, 635, 639, 641.

„ atrophy of, 1031.

„ fractures of, spontaneous, 53, 632.

„ „ traumatic, 29, 36, 43, 201, 204, 208-221, 795.

„ gunshot fractures of, 75-78.

„ hypertrophy of, 794.

„ necrosis of, after fracture, 43, 77.

„ „ from tuberculous disease, 866.

„ rickets of, 607, 608, 615, 616, 632.

„ sarcoma of, 707.

„ syphilitic disease of, 53.

„ tuberculous disease of, 516. *See also* Elbow-joint, Wrist-joint.

Rheumatoid arthritis, 174, 183, 201, 775, 787, 915-980, 1060.

„ „ of special joints. *See under the several joints.*

Ribs, achondroplasia of, 634, 637.

„ atrophy of, 344.

„ carcinoma of, spheroidal-cell, 749.

„ „ squamous-cell, 752, 753.

„ fracture of, 18-20, 163-169, 344, 607.

„ „ spontaneous, 344, 607.

„ gunshot fracture of, 67.

„ hypertrophy of, 328, 329.

„ necrosis of, 433-435.

„ rickets of, 605, 608-611, 632.

- Ribs, sarcoma of, 740.
- " tuberculous disease of, 512, 513.
- Rib-cartilages, fracture of, 170, 171.
- " ossification of, 170, 1059, 1060.
- " rickets of, 605, 611.
- Rickets, 604-632.
- " foetal, 626-632.
- " of special bones. *See under the several bones.*
  
- SACRO-ILIAC articulation, ankylosis of, 228, 953, 954, 1062, 1063.
- " tuberculous disease of, 870-873.
- Sacrum, atrophy of, 342.
- " fracture of. *See Pelvis.*
- " tuberculous disease of. *See Sacro-iliac articulation, Spine.*
- Sarcoma of bone. *See Tumours.*
- Scapula, achondroplasia of, 635, 638, 641.
- " excision of, 729.
- " fractures of, 181-187.
- " gunshot fractures of, 69, 70.
- " osseous tumour of, 683.
- " sarcoma of, chondrifying, 729.
- "                      uncertain variety, 739.
- " syphilitic disease of, 540.
- " tuberculous disease of, 514. *See also Shoulder-joint.*
- Semilunar fibro-cartilage, dislocation of, 808.
- Sequestra. *See Necrosis of Bone.*
- Shoulder-joint, acute arthritis of, 821.
- " ankylosis of, 70.
- " dislocations of, 189, 782-788.
- "                      " spontaneous, 787.
- "                      " subcoracoid, 189, 782, 787, 788.
- "                      " subglenoid, 783, 784.
- "                      " subspinous, 785.
- " excision of, 847-850.
- " rheumatoid arthritis of, 787, 918-926.
- " tuberculous disease of, 845-850.
- Skull, achondroplasia of, 633, 636.
- " altered by growth of tumours, 763-766.
- " atrophy of, 333-337, 339.
- " carcinoma of, 764, 765.
- " cephalhæmatoma of, 88.
- " contusion of, 89-92.
- " fractures of, incised and punctured, 123-128.
- "                      " involving base, 129-138.
- "                      " vault of, depressed, 10, 102-122.
- "                      "                      fissured, 9, 24, 93-101.
- " gunshot injuries of, 60-63.
- " hypertrophy of, 330, 331.
- " necrosis of, after fracture, 107.
- "                      " from suppuration of soft parts, 89-92.
- "                      " from syphilis, 399, 413, 583, 584, 588-590, 593, 594, 600, 601.
- " osseous tumours of, 681, 685, 686, 773, 774.
- " osteitis deformans of, 646, 647, 652, 653, 653 A.
- " rickets of, 607, 608, 612, 613, 632.
- " sarcoma of, ossifying and chondrifying, 646, 647, 727.
- "                      " round-cell, 709, 710, 738.
- "                      " spindle-cell, 690.
- " syphilitic disease of, 389, 397, 399, 413, 574-603.
- " trephining, 98, 101, 110, 112-122, 126-128, 774.
- " tuberculous disease of, 470-472.
- Spine, acute infective suppuration of, 451.
- " ankylosis of, 157, 483, 487, 489, 490, 500, 501, 503, 506, 507, 843, 917, 954, 1023-1026, 1055-1058, 1063.



- Spine, atrophy of, 342, 844.  
 „ dislocations of, 778-780. *See also* Fractures and Fracture-dislocations.  
 „ fractures and fracture-dislocations of, 149-160.  
 „ gunshot fractures of, 64-68.  
 „ mollities ossium of, 644, 645, 648.  
 „ necrosis of, from acute infective suppuration, 451.  
 „ „ from tuberculous disease, 491, 499, 870, 871.  
 „ rheumatoid arthritis of, 915-917.  
 „ rickets of, 608, 626.  
 „ sarcoma of, 648, 755.  
 „ tuberculous disease of, 473-509, 843, 844.  
 Spontaneous fractures, 50-56, 344, 355, 607, 608, 632, 691, 692, 697, 704, 720, 728, 744, 746, 748, 750.  
 Sterno-clavicular articulation, dislocation of, 781.  
 „ „ rheumatoid arthritis of, 174, 1060.  
 Sternum, carcinoma of, 747.  
 „ fractures of, 161, 162.  
 „ necrosis of, from tuberculous disease, 510.  
 „ tuberculous disease of, 510, 511.  
 Symphysis pubis, tuberculous disease of, 873.  
 Syphilitic disease of bone, 53, 264, 352, 375, 389, 397, 399, 413, 538-603.  
 „ „ special bones. *See under the several bones.*
- TARSUS, ankylosis, 327, 343, 532, 565, 998, 1020.  
 „ atrophy, 332, 343, 841, 998.  
 „ Charcot's disease, 997.  
 „ dislocations, 811-815.  
 „ fractures, 86, 325, 327, 811, 814.  
 „ gout, 989.  
 „ gunshot fracture, 86.  
 „ necrosis, from suppuration around, 827.  
 „ „ from tuberculous disease, 364, 532-534, 840.  
 „ neuropathic affections, 997, 998.  
 „ sarcoma (round-cell), 708.  
 „ syphilitic disease, 565.  
 „ tuberculous disease, 364, 368, 532-534, 840, 909-912.  
 Temporo-maxillary articulation, ankylosis of, 1022.  
 Tibia, achondroplasia of, 640, 641.  
 „ acute infective suppuration of, 398, 401-404, 406, 453, 457-465, 469.  
 „ atrophy of, 33, 305, 345, 461, 832, 841, 1011, 1019.  
 „ carcinoma of, 743, 745, 968.  
 „ fractures of, 1, 2, 6, 8, 12, 21, 22, 25, 26, 32-34, 39-41, 48, 49, 283, 284, 300-319, 324, 327, 379, 420, 421, 423, 424, 632, 810.  
 „ gunshot fractures of, 83, 85.  
 „ necrosis of, after fracture, 39-41, 83, 309, 327, 379, 420, 421, 423-425.  
 „ „ from injury, 414-419.  
 „ „ from suppuration around, 347, 407.  
 „ „ from tuberculous disease, 530, 895, 896.  
 „ „ *See also* Acute infective suppuration.  
 „ osseous tumour of, 664.  
 „ osteitis deformans of, 651, 654.  
 „ rickets of, 608, 616, 623-625, 627, 631, 632.  
 „ sarcoma of, melanotic, 742.  
 „ „ mixed-cell, 695, 696.  
 „ „ myeloid, 732, 733, 736, 737.  
 „ „ ossifying and chondrifying, 651, 719, 725, 726.  
 „ „ round-cell, 702, 705, 711.  
 „ syphilitic disease of, 352, 543-546, 551-565.  
 „ tuberculous disease of, 530. *See also* Knee-joint, Ankle-joint.  
 Tibio-fibular articulations, ankylosis of, 975, 1049-1051, 1053, 1054, 1064.  
 „ „ tuberculous disease of, 838, 842, 897.
- Trephining. *See* Skull.  
 Tuberculous disease of bones, 364, 368, 373, 388, 470-537.  
 „ „ special bones. *See under the several bones.*

Tuberculous disease of joints, 830-914, 1016, 1017.

" " special joints. *See under the several joints.*

Tumours of bone, 655-774.

" " alterations in bone produced by, 385, 718, 762-774.

" " cartilaginous, 655-661.

" " melanotic, 741, 742.

" " fibro-sarcomata, 687-689.

" " myeloid sarcomata, 730-737, 754, 756.

" " osseous, 662-686, 773, 774.

" " ossifying and chondrifying sarcomata, 646-651, 712-729.

" " round-cell sarcomata, 699-711, 738, 757-760.

" " secondary malignant, 55, 56, 738-753, 764, 765, 968. *See also Carcinoma of bone.*

" " special bones. *See under the several bones.*

" " spindle-cell sarcomata, 54, 690-698.

" " wax models of, 754-761.

ULNA, achondroplasia of, 639, 641.

" atrophy of, 794, 1031.

" fracture of, 36, 43, 44, 201-207, 210, 218-221, 795, 816.

" gunshot fracture of, 74-77.

" necrosis of, after fracture, 44, 74.

" " from tuberculous disease, 837, 858.

" rickets of, 607, 608, 615, 616, 629, 632.

" sarcoma of, 718.

" syphilitic disease of, 542.

" tuberculous disease of, 388, 516. *See also Elbow-joint, Wrist-joint.*

Union of fractures, 11-24.

" " irregular, 25-49.

VERTEBRÆ. *See Spine.*

WHITLOW, 431, 432, 824, 825.

Wrist-joint, dislocations of, 795, 797.

" rheumatoid arthritis of, 932, 934.

" tuberculous disease of, 866-868.

END OF PART I.















